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CONTENTS

The Genesis of the Attention in the Educative Process: PROFESSOR EDGAR JAMES SWIFT . 1

The Chemists' Club: DR. WILLIAM MCMURTRIE 5

The Work of the "Michael Sars" in the North Atlantic in 1910: HENRY B. BIGELOW 7

Scientific Notes and News 10

University and Educational News 15

Discussion and Correspondence:—

Double-mating of Silk-worm Moths: PROFESSOR W. E. CASTLE. *What is White and Black Alkali:* PROFESSOR E. W. HILGARD. *Metals on Metals, Wet:* S. W. DUDLEY ... 15

Quotations:—

Admission to Harvard College 23

Scientific Books:—

Reports to the Local Government Board on Public Health: DR. L. O. HOWARD. *Young's Lectures on the Fundamental Concepts of Algebra and Geometry:* PROFESSOR G. A. MILLER 24

Special Articles:—

Color Dispersion in the Astigmatic Eye: DR. W. G. CADY 26

The Iowa Academy of Science: L. S. ROSS . 28

Societies and Academies:—

The Philosophical Society of Washington: R. L. FARIS 31

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THE GENESIS OF THE ATTENTION IN THE EDUCATIVE PROCESS[1]

EDUCATION is suffering from a sort of dual personality. Its psychology and practise move along in more or less parallel lines without the one greatly interfering with the other. Evidence that interest, when it exists, must always follow attention to the idea or group of ideas which called it out, does not deter the enthusiastic teacher from giving this interest an external source instead of ascribing it to the mind.

Attention results from the mind's acquiescence in the focal presence of a particular idea or group of ideas. This is true whether the attention be of the so-called passive or active variety, since the only difference between the two lies in the complexity of the latter. In "voluntary" attention, more than one attraction is offered, and, each presenting inducements, the mind receives the one with more or less consciousness of what it has lost in giving up the other. This consciousness of deprivation, together with certain muscular sensations, probably makes up the feeling of effort which has caused this form of attention to be popularly thought active. Attention means a certain arrangement of the content of consciousness, which gives clearness to one idea or group of ideas, and produces comparative, though not equal, obscurity of the others. Change of attention requires a redistribution of the content, and this is accompanied by a re-

[1] Read before the joint meeting of the American Psychological Association and Section L—Education; American Association for the Advancement of Science, Minneapolis, December, 1910.

arrangement of clearness. The change may be partial or complete, depending upon the operating causes and upon the condition of the mind.

The educational problem is to secure attention for certain ideas which make for growth, and the difficulty in solving this problem is that these ideas, intended, as they are, to prepare children for the future rather than the present, are likely to represent types of experience beyond the children's stage of development. One can not avoid a certain sympathy with the eleven-year old girl who refused to try to find how many times a bucket must be filled to empty a circular well, the height and bottom radius of which were given, together with the height and radii of the bucket, on the ground that no one but a fool would try to empty a well in that way. To give attention to ideas whose value is a future asset requires rejection of those of present significance, and the mind refuses to make this sacrifice unless convinced of a more deserving claim. This is the reason for our unwillingness to listen to a friend when we are hurrying to a train.

If active attention differs from passive in the number of applicants for the limited accommodations in the focus of consciousness, the very practical question arises concerning the part the educator may play in this contest. It looks as though he enters the competition so heavily handicapped as hardly to be able to show his wares.

The feelings have been thought to be the strategic base of operations from which a successful flanking movement could be started. The innumerable and disorderly mental processes of youngsters could then, it was believed, be driven into a narrower line of march, and finally, as they became more restricted, be compelled, in sheer self-defense, to give heed to the interesting ideas which the skillful teachers always put at the head of their attacking column.

Unfortunately, however, for this theory, a little observation shows how unreliable are the feelings after we have marshalled our forces for the attack. A college student recently told the writer that, after an eloquent exposition by his professor of English history of the period of George III., it was mentioned, as an instance of that monarch's abstemiousness, that he always had boiled mutton and turnips for dinner. Now, if there are any articles of diet which this student abhors, it is boiled mutton and turnips. Consequently, all the deserving ideas related to the period of George III. were forced to yield, for the time, to the domination of turnips and mutton, and when, the following year, George III. was reached in American history, all other ideas were driven from the consciousness of this young man while he breathlessly waited again for mutton and turnips. Evidently the feelings are an unsafe educational guide, if hateful objects and ideas may be as attractive as those which are pleasant.

Again, rewards and penalties have seemed to some to be the effective means of winning the attention. The first fails on account of uncertainties regarding the sort of knowledge which will secure the reward, and the second is unproductive because the teacher and the implied punishment are too prominent in the consciousness of the learner for efficient concentration. Further, both of these incentives divide the attention. The prerequisite of a productive state of consciousness is that all diverting ideas and objects, including the teacher himself, pass out of consciousness and leave the field free for the competitive interaction of the mental processes created by the work in hand. Ideas may be forced upon children while the native impulses are restrained by penalties, much as one may be compelled to eat what does not suit his taste, but the mind refuses to

react just as gastric juice is stingy of its flow when food is unattractive. Whether, in this apparently unequal contest with native impulses, educative ideas may be aided in other ways than by relieving the mind of what may be called the school consciousness, and by giving it freedom of action, remains to be discussed.

The growing point in elementary and secondary education is the special schools for delinquents, and reformative institutions. The reason for this is that the boys in these schools are so much the primitive man that the traditional plan of education breaks down completely when applied to them. On this account, the experimental method, which until recently was regarded as so heretical as to justify the excommunication of its advocates from the communion of righteous pedagogues, was forced upon those in charge. The result is that delinquents have the best schools. And they secured them by refusing to submit to the traditional method.

Not the least curious thing about these disciplinary schools is that they require less discipline than the ordinary school. Of course, a dose of disciplinary medicine is sometimes necessary at the beginning. It has much the same value as that which David Harum attributed to fleas on a dog. Too sudden a break with one's past is likely to prove disastrous.

It should be remembered that disciplinary schools and reformative institutions deal with youngsters who can not be controlled in the ordinary school. To be able, under these circumstances, to produce in the majority of the boys a condition of consciousness attentive to study, and to develop a mental attitude responsive to social incentives is certainly remarkable. Instances of unusual influence have been often noticed, but the success is generally explained by the vague term personality. The method of these teachers, however, is strikingly similar. They secure attention to their ideas by identifying them with the racial instincts characteristic of boys.

Efficiency in education reduces itself largely to the attitude of the learner toward instruction. In the more mature, many derived interests cluster around desire for success, but in children these control elements only occasionally exist. With them, the problem is to capture a purposeless, wayward attention often enough, and to hold it long enough, to impress the mind with the significance of a few derived interests which may serve as a new base of operations from which to push on to further development. One's attitude toward knowledge depends upon the mental content. The ideas and activities of children are the stuff out of which their thoughts are made. In early life, this material is social, and it is social because it is racial.

The force of this social instinct is seen in the number of clubs formed by boys without the assistance of adults. Sheldon found[2] that seventy-two societies were represented among one hundred and seventeen boys of eight and nine years of age, and six hundred and twenty-five societies among seven hundred and forty-eight boys from ten to thirteen, inclusive. This investigation included three New England cities and two on the Pacific coast. Clearly, the social instinct is a tremendous educational force.

Johnson says[3] that the children in his vacation school preferred "to submit to a flogging as evidence that they sincerely intended to resist temptation" to disobey, "rather than to stay away from school." "Nearly every species of butterfly to be found in Andover, Mass., during the sea-

[2] *American Journal of Psychology*, Vol. 9, p. 425.

[3] *Pedagogical Seminary*, Vol. 6, p. 516.

son was captured'' by his children. Many kinds of caterpillars were watched as they developed into chrysalides in the cages, and nearly all the different kinds of fishes to be found in the streams and ponds were caught and studied. Much of this work was done outside of school hours. What enthusiasm is this for securing attention to knowledge in almost every subject of the curriculum!

A child has many possibilities, only one of which reveals itself under a given set of conditions. The self is not one and unchangeable, though it acts as a unit in a particular situation. The group offers a diversity of ideas, and the one selected is less individually selfish in proportion as it partakes of the group spirit. Children are intolerant of personal self seekers, and the group sentiment dominates partly because of its larger, more universal worth. It meets the needs of individuals through its adaptiveness to the wants of the entire group. What the group decides is for its good the individual accepts. In this way the group sentiment directs and rules the attention of those who contribute to its spirit.

Children are rarely inattentive to work which they regard as their own. The group sentiment is always active in determining what ideas shall occupy the focus of consciousness. To remain members of the group, boys must attend to business. Making children feel that the work is theirs and not the teacher's means, then, securing the attention. But this can only be done by utilizing the racial instincts in the educative process. This, the schools have failed to do and, as a result, teachers are continually working against the resistance of the group consciousness. The school is divided into two camps, the one, the teacher, trying to win attention by creating factitious interests, and the other, the children, momentarily attracted by these devices but always watchful of a chance to assert their social selves.

The productive efficiency of the energy released by group sentiment is seen in the results accomplished under the name of play. It is not the nature of the activity that distinguishes work from play, so much as the mental attitude assumed toward the occupation. The same subjects of study are tedious under the ordinary class method and interesting when made the order of business in a club of the members of the class, of which the teacher is an integral but inconspicuous part. The club idea appeals to the racial instincts of love of glory—showing off—and personal competition, both of which are elements in the group sentiment. There is no lack of attention here.

The utilization of the racial instincts in securing attention to educative ideas has been resisted by school-men largely because of the educational dogma of effort. Effort has been greatly overworked of late. Attention does its best work when the feeling of effort is wanting. Effort indicates resistance or strain, and accompanies inefficient attention. As we become proficient in our work, it decreases and, finally, disappears completely. The reverence for effort has arisen in the misapprehension of the relation of feelings to attention, and in the belief that strain has some occult pedagogical value. That which is pleasant is not for that reason easy, nor is the difficult necessarily unpleasant. It is intensity of thought which counts in mental development. The feeling of effort adds no value to the educative process. Consciousness of strain indicates imperfect attention with undue prominence of muscular sensations, or friction. The friction may be caused by the novelty of the ideas, by bodily discomfort, or by temporary mental incon-

gruity, as when one has heard bad news. If the incongruity is permanent, because of lack of ability to give the ideas an orderly arrangement, their educative value is at least doubtful.

Attention is determined by past and present states of consciousness. In childhood, these states of consciousness are largely racial and social, and continued attention can be secured only by creating educational situations in which the school consciousness loses its identity in the racial and social consciousness.

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THE CHEMISTS' CLUB[1]

I HAD the honor, I believe, of presiding over the first meeting of the New York Section of the American Chemical Society held in the Assembly Hall of what subsequently became the quarters of the Chemists' Club, and I feel honored in being invited to address the last meeting held in those quarters. At that first meeting expression was given to hopes which to some, at that time, seemed extravagant, but which have now been splendidly realized.

It will not be out of place nor without interest, I am sure, to briefly recall some of the facts and influences which led to the ultimate organization of the Chemists' Club—a club which has, for more than a decade, had such a potent influence in centralizing the interests of the chemists of New York and the vicinity, and has furnished a home for these chemists and their several societies and associations.

At the meeting of the American Association for the Advancement of Science, held in Boston in 1898, the question of the disposal of the books and other material constituting the library of the association was discussed. It was decided to consign this material to the University of Cincinnati. In the meeting of the council of the American Chemical Society held at about the same time and in the same place, inquiry was made concerning the location and condition of the books and material constituting the library of the American Chemical Society. After the closing of the old university building on Washington Square, which had housed the library for several years, all of the material had been packed in boxes and placed in fire-proof storage, where it was entirely inaccessible for consultation and use. On my return trip to New York after the close of that meeting I was accompanied by Dr. Charles F. McKenna. Our conversation naturally turned upon the material constituting the library of the society, regarding the disposition of which no decision has been made. This library was known to contain much valuable chemical material not otherwise available in this country, and it was evident that its removal from the city would be a misfortune to the local chemists. In the course of our conversation, Dr. McKenna suggested that, with the retention of the library in this city as an incentive, it should be possible to arouse sufficient interest in the matter of organizing a chemists' club to make such an enterprise an established fact.

In the year or two preceding, Professor A. A. Breneman had endeavored to arouse interest in such a project, but with no special end in view, such as the retention of the library, the effort proved ineffectual. The results were, nevertheless, influential in promoting the ultimate organization of the club as we know it.

Soon after our return from Boston, Dr. McKenna called me by telephone to tell me he believed that the inexpensive but

[1] Address before the New York Section of the American Chemical Society on March 10.

commodious quarters (which we had agreed were essential to the project) were available in the recently vacated rooms of the Mendelssohn Club at 108 West 55th Street. Upon his invitation I joined him in an inspection of the premises. We were so favorably impressed that we concluded it would be eminently advisable to call a meeting of the members of the New York Section of the Chemical Society and of other chemists in the city, for informal discussion of the desirability and practicability of establishing and maintaining such an organization of chemists as should lease and occupy the quarters referred to, the assembly hall of which was even then comfortably filled by the chemists attending the meeting. The expression of opinion was almost unanimous that the project was not only desirable, but practicable as well, and that the quarters were admirably suited to the purposes in question. The reasons were ample—there was a library to be housed and put in shape for practical use, there was need of a place for meetings of the various chemical organizations, and there was a distinct demand for a place to serve as the chemists' headquarters in both a professional and a social way. I was authorized to appoint a committee to report upon ways and means for promptly carrying out this project. I lost no time in appointing as chairman of this committee, Dr. Charles F. Chandler, who, more than any other, held the respect and esteem of the chemists of New York, and about whom these chemists would enthusiastically rally. Dr. Chandler was authorized to complete the committee, the final work of which is well known. And so the project suggested by Dr. McKenna was launched.

That the hopes we all had at that time regarding the enterprise should be so fully realized in such a comparatively short time, and that their realization should have had so important and profitable an influence upon the interests of the chemists and the chemical organizations of New York, few of us dared confidently to expect.

The Chemists' Club was finally organized in November of 1898, the constitution declaring its objects to be "the promotion of good fellowship among its members and the advancement of the science and the applications of chemistry." The quarters already described were leased and furnished and space was assigned for the library. The task of transferring the material, unpacking, classifying and shelving it was begun by Professor A. A. Breneman and finally carried out by Dr. E. G. Love, to whom is really due the credit of bringing the library to its present efficient condition. The labor involved in this work was great and was willingly rendered with no compensation other than that which must come from having so effectively promoted the interests of the chemists and the chemical organizations of both the city and the country.

The first scientific gathering held in the assembly hall of the club was the meeting of the New York Section of the American Chemical Society.

The Chemists' Club is now on the eve of another epoch in its history. While we shall experience some regret in leaving the old quarters which have served us so comfortably for such a long period, it will be with pleasant memories only, and justifiable pride that we remove to the new building of the Chemists' Club, which is a splendid monument to the foresight, judgment and generosity of the club's former president, Dr. Morris Loeb, and the efficiency of the directors of the building company, who have been charged with the financing of the enterprise and the erection of the structure. The club and the affiliated

societies will now have greater facilities than ever before.

Those of us who were associated with the club in its infancy are watching with most intense interest its evolution into maturity. We are expecting great things of the Chemists' Club and I am sure we shall not be disappointed. With its past as a background, with its organization and equipment as a foundation, and with the opportunities before it as inspiration, the auguries for the future are bright indeed.

WM. MCMURTRIE

THE WORK OF THE "MICHAEL SARS" IN THE NORTH ATLANTIC IN 1910[1]

DR. HJORT'S preliminary account of the *Michael Sars* expedition is so important, both to the oceanographer and to the marine biologist, that a résumé is justified, although the final report is yet to come.

The expedition, under the direction of Sir John Murray and Dr. Hjort, left Plymouth in April, ran thence to the west of Ireland, across the Bay of Biscay to Gibraltar, and so to the Canaries. From here the course was a "large section of the Atlantic," visiting the Azores, the Sargasso Sea and eventually Newfoundland, whence a section was undertaken to Ireland. Finally work was carried on south and north of the Wyville Thompson ridge.

Especially instructive are the hydrographic sections of the northwestern Atlantic, the observations on currents in the Straits of Gibraltar and off the Azores, the notes on the smaller plankton, and the data acquired on the bathymetric distribution of the fishes and crustaceans of the intermediate waters.

The sections from the Sargasso Sea to Newfoundland and from Newfoundland to Ireland show that the surface layer of warm water with high salinity (over 35 per m.) is very much thicker on the eastern than on the western side of the Atlantic. Off the Newfoundland bank the uniform "bottom water" with a temperature of about 2.5° C., and salinity of about 34.9 per m., rises close to the surface.

If we compare these observations with data obtained by the *Challenger* and by the *Blake*, with the scattered records made by the *Albatross*, and with the few temperatures I have myself taken in the intermediate waters of the Gulf Stream, we find that they are all in accord on this main point. In the northern portion of the Gulf Stream its warm waters are extremely shallow along its inner edge.

The two sections in question illustrate what to the oceanographer is a most important discovery; viz., an upwelling of the cold bottom water partially dividing the warm surface layer into two bands. Thus on the line Newfoundland-Ireland, the temperature at station 83 at about 275 fathoms is the same as it is at 350 fathoms at stations 81 and 85, east and west of it; *i. e.*, 8° C. (46.4° F.). And the salinity curve shows a similar rise. On the line Sargasso Sea-Newfoundland, the "sunderance" of the warm surface water is much more extreme. Thus at station 66 water of 8° C. (46.4° F.) was found at only about 150 fathoms, and of only 14° C. (57.2° F.) and salinity of 35 per m. within less than 50 fathoms of the surface.

On looking over the *Challenger* temperatures on the line Halifax-Bermuda, taking the actual observations, and not those computed from the "average curve" I was struck by the fact that at station 53, at roughly the same relative position, the temperature at 100 and at 300 fathoms was about the same as it was about 50 fathoms deeper at stations 52 and 54, on either side of it. The variation of only about 1° F. is a very slight one, but taken in conjunction with the observations of the *Michael Sars*, and with the fact that the upward swing of the isotherms lies in the direct continuation of the cold ridge shown by Dr. Hjort in his chart of the conditions at 200 fathoms, it certainly suggests the *possibility* that it was an actual phenomenon in 1873 as it was in 1910, not a faulty observation.

Dr. Hjort suggests that if this remarkable

[1] Johan Hjort, "The 'Michael Sars' North Atlantic Deep-sea Expedition, 1910," *Geographical Journal*, Vol. 37, 1911, pp. 349–377, 500–523.

phenomenon proves to be a regular feature, which is, of course, still doubtful, it indicates the existence of a counter current running to the southwest. This may be the correct explanation. But, as he cautions us, it requires further investigation, especially to test its constancy. Vertical circulation, as well as horizontal, may be playing its part here. Current measurements at different depths could not fail to yield valuable results.

As a whole the intermediate waters proved to be considerably colder in 1910 than they were in 1873, differences as great as 5° C. being observed, though the surface and the deeper layers agreed fairly well wherever the paths of the two expeditions approached each other. Such periodic fluctuations are known for the Norwegian Sea, but they offer a virgin and most interesting field in the northwestern Atlantic.

The shallowness of the warm surface layer in the western part of the Atlantic leads Dr. Hjort to conclude that its cold bottom waters come to it from the northwest; *i. e.*, from Baffins Bay. In this connection an examination of the Labrador current would be of great value; as yet we know almost nothing about the physical properties of the intermediate waters north of, and at its meeting with, the Gulf Stream, though its importance as a surface phenomenon has long been recognized.

The character of this Arctic flow, and its relationships to the Gulf Stream and to the comparatively warm water along the western shores of Greenland offer an attractive and important field for oceanographic research, one lying naturally at the doors of American oceanographers. In such a study, current measurements at different depths on and near the Newfoundland banks would be of prime importance. And that such can be made in considerable depths has been proved by the *Michael Sars*.

A series of 70 current measurements were made at eight different depths in the Straits of Gibraltar, from the ship itself, in 200 fathoms. These show very clearly how the inflow into the Mediterranean is limited to the upper 75 fathoms (about) while at its height, with a velocity of about 1 m. per second. On the other hand, when the outflow was at its height the surface current was slight, whereas the current into the Atlantic reached the velocity of 2 m. per second.

A second series of measurements off the Azores show that there may be considerable tidal currents, even as deep as 800 meters.

The biological results are quite as important as the oceanographic. With regard to the finer plankton, the most important results are that there is much more in coastal than in oceanic waters, and that in oceanic waters the maximum of vegetable plankton was at about 50 meters, less at the surface.

By the time 100 meters was reached there was only about one tenth as much as 50. Dr. Hjort tells us that the different groups occupy different bathymetric zones, the Peridiniæ nearest the surface, next the coccoliths, and deeper the diatoms. As to quantity, the living plant cells are estimated at 3,000 to 12,000 per liter of sea water.

The collection of the larger plankton, fishes, crustaceans, etc., was very rich; and the depth data were valuable, thanks to the method of using the serial nets developed by Dr. Hjort. For the details of the apparatus I must refer the reader to Dr. Hjort's account; but, essentially, it consisted in using a series of ten different horizontal nets simultaneously at each station. It seems to me, as it did to Dr. Hjort, that "provided that the catches were large . . . the mere numbers would demonstrate *sufficiently convincingly* at what depth the captures had been made."

The data on the vertical occurrence of fishes and crustaceans have proved to be most valuable—they throw an entirely new light on the whole subject. In the first place they show very clearly that the intermediate fishes and crustaceans are not homogeneous so far as their bathymetric range is concerned, but that species closely allied systematically may differ in their distribution. Thus the fish *Cyclothone microdon* and the prawn, *Acanthephyra multispina*, belong to a deeper zone than their relatives *C. signata* and *A. pur-*

purea. Adults of the former group were most abundant below 500 meters, larvæ (*Acanthephyra*) alone were taken in the upper layers of water. The oldest specimens were from the deepest layers, down 1,500 m., and the depth zones for corresponding sizes were deeper on the southern than on the northern lines. The second group, on the other hand, reaches its maximum higher up, at about 500 m., but here too the older specimens were found deeper on the southern than on the northern lines.

As a rule black and red forms prevail among the larger inhabitants of the intermediate waters. This rule is not absolute, since two species of black fishes were found within 150 m. of the surface. But these two, like *Cyclothone signata,* have highly developed light organs. And it is even more significant that all the captures of them from depths less than 500 m. were made at night; furthermore, as Dr. Hjort points out, there are previous records of black fishes, *e. g., Idiacanthus* and *Astronesthes,* being taken close to the surface at night.

Experiments on the penetration of light, carried on by means of an improved photometer, devised by Dr. Helland-Hansen, showed that there is a close correlation between the lower limits of light of different colors and the vertical occurrence of the black fishes and red prawns. Off the Azores the blue and violet rays were still detected at 500 meters, though the red had been absorbed entirely; at 1,000 meters the ultra-violet rays were still perceptible, but at 1,700 no trace of light was found. That is to say, prawns and black fishes, in the day time, are confined to a zone below the penetration of red light: it is only at night that the fish with large light organs are found higher up in the water. While their upper limit is higher in high than in low latitudes, the same must, on physical grounds, be true of the penetration of light. Furthermore, the theoretical calculations of the penetration of light at different latitudes shows that it agrees very well with the upper limits of the red prawns from the lines of the *Michael Sars* and from the Norwegian Sea.

At a higher level than that occupied by the red and black forms, where sunlight is appreciable, *i. e.,* with a lower limit, in temperate latitudes, of say 500 m.; and a maximum at about 300 m. is a totally distinct fish fauna, characterized by lateral compression, larger and often telescopic eyes, large light organs and silvery sides, examples being afforded by *Argyropelecus* and by various Sternoptychidæ and Stomiatidæ.

These observations rest on such a mass of data that they seem altogether worthy of acceptance. They form one of the most important of recent additions to oceanic biology. They are of special interest to the reviewer because of his studies on the medusæ of the intermediate waters collected by the *Albatross.* Among the latter, as among the fishes, there are two distinct color groups, one slightly pigmented, if at all, but iridescent; the other densely pigmented with red or brown. Both have numerous representatives. Our knowledge of their vertical occurrence is still scanty; but we know that they do not normally come to the surface, except in very high latitudes. On the other hand, they are by no means confined to abyssal depths. The important question in connection with Dr. Hjort's article is whether the two color-groups of medusæ correspond to the two color-groups of fishes in their bathymetric occurrence. To this an answer can not be given definitely as yet. I have already suggested[2] that it is light which demarks their upper limit as a whole. And it is at least suggestive that at one station in the eastern tropical Pacific the *Albatross* took 3 genera of "red" medusæ in a Tanner closing net at 400 fathoms (one of them being also taken in an open net from 300 fathoms), but none of the "iridescent" group, while at the same station two "iridescent" genera were taken in the closing net from 300 fathoms, and two others in the open net from the same depth. These records suggest that at this station, at least, the red medusæ occurred as a whole below the iridescent ones, but that the two overlapped at, say, 300–250 fathoms. One may

[2] *Mem. Mus. Comp. Zool.,* Vol. 37.

hope for much more extensive, perhaps conclusive, evidence along this line when the medusæ of the *Michael Sars* are worked up.

Dr. Hjort believes that the zone marking the upper limit of the red and black forms is particularly rich quantitatively, a view to which I subscribe, having already argued that it is probably true for the medusæ. If his observation that there is a sudden rise in density as we go down through the intermediate layers, where sinking organic débris would tend to accumulate, be extended to the oceans as a whole, it must be one of the most important factors in the ecology of the mesoplankton. In this connection, of course, it is neither salinity nor specific gravity reduced to a standard temperature which is required, but the density of the water at the temperature *in situ*.

Among the mass of surface forms Dr. Hjort mentions especially the transparent fish larvæ, 90 per cent. of which were secured within 150 meters of the surface; of special interest being the occurrence there of pale larvæ of the black *Gonostoma elongatum*, and of deep-sea macrurids. On the other hand, the larvæ of other deep-water forms were taken at about the same bathymetric levels as the adults. In these cases the larvæ are not transparent, but show the pigmentation of the adult. Their color and vertical occurrence are correlated from the earliest stages.

The notes on horizontal distribution are valuable. Thus the captures have extended the ranges of several "rare" deep-water forms to practically the whole north Atlantic; others, however, especially several species of *Cyclothone*, seem to be limited to southern regions. The three centers of abundance for transparent young fish were south of the Azores, west of the Canaries, and off the Newfoundland bank. Among them many interesting stalked-eyed forms were taken, and large series of Leptocephali of at least 20 species.[3]

Finally we have an account of the trawlings. As yet the material is only partially worked up; and as the results may be expected to be of great general interest, it is best to delay our review of them till the final account appears, merely pointing out here the uniformity of the fish fauna at 500 fathoms, from the Wyville Thomson ridge to the Canaries, as opposed to its great diversity in shallow water. The work also supported earlier conclusions that there are some species of fishes and invertebrates south of the ridge separating the Atlantic from the Norwegian Sea, not found north of it, and *vice versa*.

In conclusion, every student of oceanic phenomena owes a debt of gratitude to Dr. Hjort and to Sir John Murray for the well-planned and successfully executed operations of the expedition. The methods employed deserve to be, and will be generally, adopted. To those of us who have participated in deep-sea investigation, it is a revelation that so much and such good work could be done from a vessel of only 226 tons, and that financial obstacle need no longer loom so large as it has in the past.

As Dr. Hjort points out, the Atlantic is still a "fruitful field for future investigation into the pelagic life of the ocean"; and he has himself opened many attractive vistas to other students.

Henry B. Bigelow

[3] Some of these, the larvæ of the European eel, have been described in an earlier paper (*Nature*, November 24, 1910).

SCIENTIFIC NOTES AND NEWS

Dr. Abraham Jacobi, emeritus professor in Columbia University, was elected president of the American Medical Association, at the meeting held last week at Los Angeles.

Professor William G. Raymond, head of the department of civil engineering and dean of the College of Applied Science at the State University of Iowa, has been elected president of the Society for the Promotion of Engineering Education.

Harvard University has conferred the doctorate of letters on Dr. Josiah Royce, professor of philosophy, and the degree of master of arts on Dr. William B. Coley, professor of clinical surgery in Cornell Medical College,

on Professor Henry S. Graves, chief forester of the U. S. Forest Service, and on Major W. V. Judson, of the corps of engineers of the U. S. Army.

DARTMOUTH COLLEGE has conferred its doctorate of science on Professor Edwin B. Frost, of the class of '86, director of the Yerkes Observatory and formerly professor of astronomy at Dartmouth College.

AMHERST COLLEGE has conferred its doctorate of laws on Dr. Walter Wyman, of the class of '70, surgeon general of the U. S. Public Health and Marine Hospital Service.

THE degree of doctor of engineering has been conferred by the University of Illinois upon Mr. Ralph Modjeski, bridge engineer.

DR. R. A. MILLIKAN, professor of physics in the University of Chicago, has been given a doctorate of science by Oberlin College.

THE Jefferson Medical College has conferred the degree of Sc.D. on Dr. Victor G. Heiser, class of 1896, director of health in the Philippine Islands.

THE Royal Society of Arts has awarded its Albert medal for the current year to the Hon. Charles A. Parsons, F.R.S., for his experimental researches on steam engines of the turbine type.

DR. L. HEKTOEN, of the Memorial Institute for Infectious Diseases, Chicago, has been elected foreign member of the Norwegian Medical Society of Copenhagen.

DR. P. WALDEN, professor of chemistry at Riga, has been elected a member of the St. Petersburg Academy of Sciences, with the privilege of retaining for the present his chair in the Polytechnic School at Riga.

DR. SVEN HEDIN, the Swedish explorer, has been elected a member of the Paris Academy of Sciences.

PROFESSOR V. ESMARCH, of Göttingen, has resigned the direction of the hygienic institute on account of illness and has been relieved from giving lectures.

DR. ALBERT EULENBURG, professor of diseases of the nervous system at Berlin, celebrated the semi-centennial of his doctorate on May 31.

THE eighth volume of the "Contributions from the Jefferson Physical Laboratory" is dedicated to Professor John Trowbridge, the director emeritus. The volume contains twenty-six papers, and has the following dedication to Professor Trowbridge:

TO JOHN TROWBRIDGE

who projected a great physical laboratory for Harvard University and found the means to build and equip it, who by his foresight, invention and care has kept this laboratory among the foremost in opportunities for scientific achievement, and by his magnanimity has made it a place proverbial for good feeling, this volume is gratefully and affectionately dedicated by those who have profited by his labors and enjoyed his friendship.

UNDER authority recently given by congress, Surgeon General Wyman has designated the U. S. Marine Hospital at Wilmington, N. C., as a special research hospital for zooparasitic diseases. Professor C. W. Stiles, of the Hygienic Laboratory, has been ordered to divide his time between Washington, D. C., and Wilmington. He will have charge of the biological side of the investigations while Surgeon Charles H. Gardner will have charge of the more strictly medical side of the work. The new law permits the hospital to take in free patients, not to exceed ten in number at any one time, for study of infectious and contagious diseases. Dr. Stiles takes three assistants to Wilmington. A camp of six tents has been erected in the hospital grounds for quarters.

DR. OSKAR HECKER, observer in the Geodetic Institute at Potsdam, has been appointed director of the bureau of the International Seismological Association at Strassburg.

DR. LOUIS SIMONIN, assistant director of the Nice Observatory, has been appointed astronomer in the Paris Observatory.

DR. OTTO KLOTZ, of the Dominion Observatory, will attend the Manchester meeting, July 18–22, of the International Seismological Association as delegate for Canada.

Mr. Sidney L. Galpin, of the department of geology at Cornell University, is director of a party of Oberlin students doing summer work in geology in western Virginia.

Dr. Frank M. Surface, of the Kentucky Experiment Station, sailed for Europe on June 30 to spend six months in study and travel.

An expedition to Newfoundland in the interest of the Gray Herbarium, Harvard University, under the direction of Professor Fernald, left Boston on June 30. Professor Fernald is accompanied by Professor Karl M. Wiegand, of Wellesley College, and Messrs. Edwin B. Bartram and Bayard Long, of the Academy of Sciences of Philadelphia, with Mr. Henry T. Darlington, a graduate student, as general assistant. Headquarters will be at Grand Falls on the Exploits River, and the explorations will be chiefly on the northeast coast of the island, thus supplementing the former explorations of Professors Fernald and Wiegand on the northwest coast.

A bronze statue of Dr. Traill Green has been erected at Easton, Pennsylvania, where he was a practising physician until his death in 1897 at the age of eighty-four years. He had also been professor of chemistry at Lafayette College and dean of the scientific department.

Funds are being collected for the purpose of erecting a monument to honor the memory of the late Professor Cesare Lombroso, at his native place, Verona, Italy.

Professor Julian William Baird, dean of the Massachusetts College of Pharmacy and professor of chemistry, died on June 26, in his fifty-third year.

Sir Rupert Boyce, Holt professor of pathology in the University of Liverpool, known for his important contributions to our knowledge of nervous and tropical diseases, died on June 16, aged forty-nine years.

Dr. K. Polstorff, associate professor of pharmacological chemistry at Göttingen, has died at the age of sixty-six years.

Dr. Charles G. Weld has bequeathed to the Boston Museum of Fine Arts his collection of Japanese paintings and lacquer work which has been in the custody of the museum as a loan collection and to the Peabody Museum at Salem all the property now in the custody of that institution, including the collection from the South Seas, and the sum of $25,000.

The death is announced of Dr. Heinrich Stilling, professor of pathological anatomy at Lausanne.

M. Pedro Christoffersen, a Norwegian, of Buenos Aires, has offered to pay the expenses for the provisions and other outfit of the *Fram*, Captain Amundsen's ship, both during the ship's stay at Buenos Aires and during the oceanographic expedition to the Antarctic seas now being conducted by Captain Amundsen. He will also bear the expenses of outfit when the *Fram* returns in August next in order to fetch Captain Amundsen and his companions in the coming spring.

Mr. George Robert White, of Boston, has subscribed the sum necessary to rebuild and considerably enlarge the laboratories connected with the Gray Herbarium. The new structure will be a two-storied thoroughly fireproof wing, sixty feet long and thirty broad, extending from the central portion of the building toward the conservatories. The lower story will contain two laboratories for work in systematic and geographic botany, while a portion of the upper will be equipped for the herbarium of the New England Botanical Club. Mr. White's gift includes $21,500 for construction and $10,000 for equipment. The cases and, so far as possible, the other furnishings will be of steel. Through an anonymous gift of $25,000, announced some weeks ago, the herbarium will also be provided with a library wing, to extend from the main building toward Garden Street and to cover a portion of the site formerly occupied by the Gray residence, recently removed. Plans for these two extensions, prepared by Mr. W. L. Mowll, have been approved by the corporation and construction will begin as soon as practicable. Mr. Casimir de Candolle, of Geneva, has given to the Gray Herbarium a cast of a

bust of his father, Alphonse de Candolle, in remembrance of the constant friendship between his father and Asa Gray. The bust is by Hugues Bovy.

THE Arnold Arboretum of Harvard University announces the publication of the first volume of "The Bradley Bibliography," a guide to the literature of woody plants, including books, and articles in the proceedings of learned societies, and in scientific and popular journals, published in all languages to the end of the nineteenth century, prepared at the Arnold Arboretum by Mr. Alfred Rehder, under the direction of Professor Charles Sprague Sargent. The work will extend to between 4,000 and 5,000 quarto two-column pages and will consist of five volumes, as follows: I., Dendrology—General; II., Dendrology—Taxonomic Arrangement; III., Economic Products and Uses of Woody Plants—Arboriculture; IV., Forestry; V., Index of Authors and Titles.

THE *Geographical Magazine* gives some details in regard to the piercing of the Lötschberg in the Bernese Alps, completed on March 31 by the junction of the galleries driven from the north and south which marks an important step towards improved communications across the Alpine barrier of central Europe. The project forms the natural complement of the piercing of the Simplon, in supplying a further link in the future trunk line of communication from northwestern to southern Europe, besides giving to Berne (in the interests of which city the scheme was first set on foot) its needed access to the more westerly of the two great international routes across Switzerland, between which it has hitherto lain isolated. The northern entrance to the tunnel, at Kandersteg, is reached by a prolongation of the line up the Kander Valley from Spiez on the Lake of Thun, and the southern, at Göppenstein, is linked with the Simplon at Brieg by a section descending the Lötschenthal at the Rhone Valley. The total length is 14,536 meters (9 miles), or but slightly shorter than the St. Gothard, though over 5,000 meters shorter than the Simplon, these being the only two existing tunnels by which it is exceeded. The length is nearly half a mile greater than was provided by the original scheme, a departure from the straight line having been necessitated by the catastrophe of 1908, which flooded the workings and entailed the loss of twenty-five lives, rendering nearly a mile of the boring useless. In spite of this delay, the piercing of the mountain, begun on October 15, 1906, occupied less than four and a half years, the rate of progress per day being greater than in the case of any of the previous great alpine tunnels, though closely approached in that of the Simplon. While not in any way affecting the communications between Paris and the south, and only in a minor degree those of the Rhine and southwest Germany, the new route will effect an appreciable shortening of the journey from London (and northeastern France) to Milan and other parts of Italy by the Calais-Belfort route, particularly when the projected tunnel, 4 miles long, under the Jura north of the Lake of Bienne has been completed; the saving will be most noticeable in the case of Genoa. The date fixed for the opening of the Lötschberg route, on which electric traction will be used, is May 1, 1913.

THAT the sulphur in our soils, hitherto considered of little importance to the fertility of the same, is of vast importance, and is also being rapidly depleted due to improper methods of agriculture, is the gist of a bulletin published by the University of Wisconsin, embodying the results of experiments conducted by Professor E. B. Hart and Mr. W. H. Peterson, of the department of agricultural chemistry. Sulphur has been considered relatively unimportant as compared with phosphorus and nitrogen content of soils. Tests made by Professor Hart and Mr. Peterson show, however, that low results were due to the analytical methods employed by the early investigators, and according to more accurate determinations the sulphur content of our soils is of vast importance. Continuous cultivation, in connection with insufficient fertilization, annually results in a heavy loss of sulphur. Combined with the losses of sul-

phur through drainage and the low original sulphur content of the soil, it appears that this loss can not be compensated by the sulphur obtained from the atmosphere. The surface eight inches of the normal soil contains only enough sulphur trioxide for about 100 normal crops of barley. The fact that the subsoil also has a low sulphur content, shows that the upward movement of capillary water can not bring much sulphur to the surface. In a word, it is necessary to apply fertilizers containing sulphur to maintain the crop yields of such soils. The conclusions derived from these experiments show that the sulphur content of a number of the common farm products, as previously determined, has been too low and that much sulphur trioxide is removed by crops from the soil—more than has been supposed. In fact, soils cropped continuously for half a century with infrequent applications of fertilizers have lost as high as 40 per cent. of their original sulphur.

At the suggestion of Dr. Paul G. Woolley, dean of the medical faculty of the College of Medicine of the University of Cincinnati, and with the active cooperation of Dr. John H. Landis, health officer, and Dr. William H. Strietmann, assistant health officer, the board of health of the city has voted that students of the college may have a complete service in all departments of the health department of the city. This cooperative work will begin in the junior year and each student will in his last two years complete a practical course in public health and sanitation. This work will include the usual chemical and bacteriologic work of health departments; water supply, and sewage disposal; disposal of the dead; sanitary, tenement, and house inspection; meat, vegetable and dairy inspection; school inspection and vaccination; tuberculosis field work including dairy work; and actual epidemiologic work including tracing of cases and sources of infection; and finally statistical work, and methods of making and filing reports.

There was an increase of $220,665,617 in the value of metals produced in the United States in 1909 over the value in 1908, as shown by an advance chapter from "Mineral Resources of the United States, 1909," on "The Production of Metals and Metallic Ores in 1908 and 1909," by Waldemar Lindgren, just issued by the United States Geological Survey. In 1909 the total production had a value of $870,445,230; that for 1908 was valued at $649,779,613. Pig iron led in 1909, both in quantity and in value, the output being 28,638,883 short tons, valued at $411,544,773, of which 27,689,883 tons, valued at $397,907,510, was derived from domestic ores. Refined copper, gold, silver and lead, in value of production, followed in the order named. Our own mines produced 57,449,584 short tons of iron ore in 1909, as against 40,301,336 short tons in 1908. Copper ores came next, with 28,025,092 short tons in 1909 and 22,358,857 tons in 1908; zinc and zinc-lead ores were next, with 10,679,608 short tons in 1909 and 8,157,963 tons in 1908; gold ores followed, with 9,241,827 short tons in 1909 and 8,991,751 short tons in 1908; lead ores were fifth in order of total production, with 5,811,687 short tons in 1909 and 5,082,853 short tons in 1908.

Nature announces that an International Association of Chemical Societies has been formed as the result of a conference of delegates from the chemical societies of England, France and Germany, held in Paris on April 5 and 26. The three leading societies of the countries named had been invited by the president of the Chemical Society of France to cooperate in this movement and to nominate delegates to represent their respective societies at the inaugural meeting. The representatives of the Chemical Society of London were Professor P. F. Frankland (president), Professor Meldola and Sir Wm. Ramsay. The Chemical Society of France was represented by Professors Béhal, Haller and Hanriot, and the German Chemical Society by Professors Jacobson, Ostwald and Wichelhaus. With the exception of Professor Meldola, who was unable to attend, all the delegates were present at the opening meeting, when the association was formally founded

and the statutes framed and adopted. From these statutes we learn that the objects of the association are to be promoted by the appointment of committees charged with the consideration and investigation of questions submitted by the council, by the publication of the results of such investigations and by the holding of conferences and congresses. It was decided at the opening meeting that the first international committees should be appointed for dealing with the questions of nomenclature in mineral and organic chemistry, and with the unification of the modes of stating physical constants. The next meeting of the association is to be held in Berlin on April 13, 1912, with Professor Ostwald as president, and the 1913 meeting is to be held in Great Britain.

UNIVERSITY AND EDUCATIONAL NEWS

THE governor of Pennsylvania has approved a bill giving an appropriation to the Schools of Mines, Engineering, etc., of the University of Pittsburgh, amounting to $400,000.

HARVARD UNIVERSITY has received from the class of '86 $100,000 to be used without restriction for the purposes of the college.

PRESIDENT TAFT, upon recommendation of the secretary of the interior, has forwarded to the senate the nomination of Professor Philander P. Claxton, professor of education in the University of Tennessee, as commissioner of education to succeed Dr. Elmer E. Brown, who recently resigned to accept the chancellorship of New York University.

DR. MICHAEL F. GUYER, of the University of Cincinnati, has been appointed professor of zoology in the University of Wisconsin.

PROFESSOR J. A. FERGUSON, of the Pennsylvania State College, has been appointed professor of forestry in the College of Agriculture of the University of Missouri. The College of Agriculture owns fifty thousand acres of forest lands in the southern part of Missouri. It is planned to utilize these lands as an out-door laboratory for the instruction in practical forestry.

FRANK LOXLEY GRIFFIN, Ph.D. (Chicago), assistant professor of mathematics at Williams College, Williamstown, Mass., has been appointed professor of mathematics at Reed College, the new institution at Portland, Ore., which is to open September 18, 1911.

THE REV. ALAN S. HAWKESWORTH has resigned from a lectureship in higher mathematics and semitic languages in the University of Pittsburgh.

PROFESSOR GEORGE D. HUBBARD, head of the department of geology at Oberlin College, has charge of the work in geology and geography at Ohio State University during the summer session.

W. H. LONGLEY, Ph.D., instructor in biology in Yale University, has been appointed assistant professor of biology in Goucher College.

WILLIAM CUMMING ROSE, Ph.D., formerly assistant in the Sheffield Scientific School, Yale University, has been appointed assistant instructor in physiological chemistry at the University of Pennsylvania.

DISCUSSION AND CORRESPONDENCE

DOUBLE MATING OF SILK-WORM MOTHS

IN SCIENCE for May 19, 1911, Professor Kellogg reports certain double mating experiments with silk-worm moths, of which he invites criticism. His account leaves one with the general impression of a "perturbation in the order of inheritance" due to the presence of spermatozoa furnished by two different males. Several possible explanations are suggested by Kellogg, none of which however is advocated. For example, he inquires:

> Do the eggs in double-mated females receive more than one spermatozoon and are these spermatozoa often the representatives of both races used in the double mating? Or can the egg be in any way influenced by the mere presence in the spermatheca of spermatozoa representing both of a pair of allelomorphic heritable characters? Can fluids carrying the spermatozoa have any influence during fertilization? Can the spermatozoa of one type influence those of the other type during their enforced companionship for several hours or days in the female spermatheca?

Admitting that our present knowledge would lead us to answer these various questions in the negative, Kellogg closes with the inquiry:

> Then why should the order of inheritance in the silkworm moth be different in the generations after these double matings from the order in the generations following a single mating?

But is it? I think not. And since it would seem to be of doubtful wisdom to seek possible explanations for a fact which is not true, let us first make sure of the fact.

Kellogg presents his data without any attempt at analysis, and this fact I think has led him, as it naturally does the reader, to suppose that the ordinary Mendelian inheritance of cocoon color is in these matings much disturbed. Before any critical discussion of the data is possible they must first be classified. Comparison may then be made with the behavior of the same races in *single* matings, which Professor Kellogg himself has given us in part in his 1908 paper.

In agreement with Coutagne (1902) and Toyama (1906), Kellogg finds that the inheritance of cocoon color in silkworms follows in general the Mendelian laws of dominance and segregation. Yellow color usually dominates over white in crosses, but in the case of certain races the dominance is not uniform. Yellow dominates over white in part of the zygotes only, in the remainder white dominates over yellow. This fact was first observed and clearly recorded by Coutagne (1902), who, though at that time unacquainted with the Mendelian laws, presented clear and convincing evidence of their applicability in the cases studied by him. Discussing Coutagne's results in 1905[1] I pointed out the fact (which Kellogg seems to have overlooked) that in cases where yellow dominates in F_1, there occur in F_2 three yellows to one white, whereas, when white dominates in F_1, there occur in F_2 three whites to one yellow. In other words the character which behaves as dominant in F_1 continues to behave as dominant in F_2. Kellogg's experiments show this same result both in single and in double matings, as I shall presently point out.

It happens that Kellogg has used in his double mating experiments a white race (Bagdad white) which is sometimes dominant,[2] sometimes recessive in crosses with yellow, and this seems to have been the real reason why he thought the "inheritance perturbed" by double mating. As a matter of fact the perturbation is no greater in the double than in the single matings.

In 1908 Kellogg reported the results of six crosses of Bagdad white with Istrian yellow, which were carried through two generations, as shown in Table I. One of the seven original matings produced only yellow offspring, two produced only white, and four gave a mixed progeny consisting of 82 whites and 60 yellows. Six matings of F_1 yellows *inter se* produced in F_2, 117 whites : 350 yellows, or 1w : 3y. Six matings of F_1 whites *inter se* produced in F_2, 418 whites : 140 yellows, or 3w : 1y. In both cases, it will be observed, the character which dominated in F_1 was in F_2 approximately three times as numerous as the other, a consistent Mendelian behavior. Further, when white dominant in F_1 was mated with yellow dominant in F_1, the result was the production of both sorts in numbers approximately equal. Seven such matings produced, in F_2, 324 whites and 381 yellows, or 1w : 1.2y.

[1] Carnegie Institution Publication, No. 23, p. 59.

[2] Kellogg expressly recognizes (p. 784) the frequent behavior of Bagdad white as a dominant character in crosses with yellow in single matings, yet on page 788 makes the surprising statement: "After a double mating the whites of the F_1 generation mated with other whites of the same generation do not always produce whites. They may produce both yellows and whites." [Certainly! If white is dominant, it should behave in just that way.] Kellogg then continues: "Or this latent carrying of the yellow character by these presumably strictly recessive (white) carriers may not be manifest till an F_3 generation." Kellogg then proceeds to seek an explanation in the double mating of the mother, having forgotten apparently his express statement on page 784 that Bagdad white frequently behaves as a *dominant*, which fact would explain everything.

TABLE I. RESULTS OF SINGLE MATINGS OF BAGDAD WHITE WITH ISTRIAN YELLOW SILKWORM MOTHS

F_1		F_2		
White	Yellow	Parents	White	Yellow
31	21	W × W	57	31
		W × W	51	18
		Y × Y	34	86
		Y × Y	7	42
		W × Y	26	40
		W × Y	36	29
10	9	Y × Y	11	26
		W × Y	54	56
		W × Y	67	45
all	0	W × Y[1]	41	66
31	21	W × W	85	26
10	9	W × W	86	33
		Y × Y	13	71
		W × Y	48	72
		W × Y	52	73
all	0	W × W	77	17
		W × W	62	15
0	all	Y × Y	24	64
		Y × Y	28	61
Summary		*6*W × W	*418*	*140*
		*6*Y × Y	*117*	*350*
		*7*W × Y	*324*	*381*

In double matings of these same races there is only this difference to be borne in mind; the egg may have been fertilized *either* by a sperm of the same race or by one of the other race. In the former case we should expect the F_1 individuals all to be like the mother, and *all to breed true in* F_2, whereas in case of a cross we should expect F_1 sometimes and F_2 always to consist of a mixed brood.

Kellogg reports six such double matings (Tables II. and III.), three of which gave all yellow F_1 broods (except for a single possible "straggler"); one mating gave only white F_1 offspring, while two gave both sorts in F_1. Seven pairs of F_1 whites (from a Bagdad white mother, Table II.) gave only whites in F_2 as well as in F_3. Clearly the egg of the Bagdad mother was in each of these cases fertilized by sperm of the same race. At any rate the behavior through three generations is exactly the same as in the pure Bagdad race and shows no "perturbation" whatever.

[1] From F_1 of last cross in Table I.

One other mating of F_1 whites *inter se* gave in F_2, 46 whites : 15 yellows, or 3w : 1y, as we should expect the white F^1 individuals to do when produced by a *single* mating between the white and the yellow races used.

TABLE II. RESULTS OF MATING BAGDAD WHITE FEMALES DOUBLY, VIZ., WITH BAGDAD WHITE AND WITH ISTRIAN YELLOW MALES

F_1		F_2			F_3		
White	Yellow	Parents	White	Yellow	Parents	White	Yellow
15	57	W × W	11	0	W × W	all	0
		W × W	all	0	W × W	all	0
		W × W	all	0	W × W	all	0
		Y × Y	6	22	W × W	35	0
					Y × Y	0	24
		Y × Y	9	20	W × W	25	0
					Y × Y	12	21
		Y × Y	4	17	Y × Y	8	20
		W × Y	12	12	W × W	19	0
					Y × Y	10	17
		W × Y	16	20	W × W	6	0
					Y × Y	8	6
					W × Y	4	12
		W × Y	5	31	W × W	19	0
					Y × Y	0	9
41	0	W × W	59	0	W × W	all	0
		W × W	all	0	W × W	all	0
		W × W	46	15	W × W	all	0
					Y × Y	0	all
48	20	W × W	all	0	W × W	all	0
		W × W	all	0	W × W	all	0
		Y × Y	9	12	W × W	all	0
					Y × Y	0	all
		Y × Y	1	26	Y × Y	2	14
		Y × Y	12	28	W × W	15	1(?)
					Y × Y	0	50
		W × Y	40	16	W × W	28	29
					Y × Y	5	34
		W × Y	20	19	W × W	70	0
					Y × Y	6	9
0	29	Y × Y	8	25	W × W	all	0
		Y × Y	6	12	W × W	all	0
					Y × Y	6	9
		Y × Y	9	30	Y × Y	0	all
		Y × Y	4	19	Y × Y	5	29
Summary		*7*W × W	*all*	*0*	*7*W × W	*all*	*0*
		*1*W × W	*46*	*15*	*1*W × W	*all*	*0*
					*1*Y × Y	*0*	*all*
		*10*Y × Y	*68*	*211*	*6*W × W	*all*	*1*(?)
					*5*Y × Y	*33*	*93*
					*4*Y × Y	*0*	*all*
		*5*W × Y	*93*	*98*	*4*W × W	*all*	*0*
					*1*W × W	*28*	*29*
					*1*Y × Y	*0*	*9*
					*4*Y × Y	*29*	*66*
					*1*W × Y	*4*	*12*

TABLE III. RESULTS OF MATING ISTRIAN YELLOW FEMALES DOUBLY, VIZ., WITH ISTRIAN YELLOW AND WITH BAGDAD WHITE MALES

F_1		F_2			F_3		
White	Yellow	Parents	White	Yellow	Parents	White	Yellow
1(?)	55	Y × Y	10	23	Y × Y	2	12
		Y × Y	13	28			
		Y × Y	10	24	W × W	4	0
					Y × Y	16	0
0	30	Y × Y	4	16			
		Y × Y	4	19			
Summary		5Y × Y	*41*	*110*	*1*W × W	*all*	*0*
					*1*Y × Y	*2*	*12*
					*1*Y × Y	*all*	*0*

Fifteen matings of F_1 yellows *inter se* (Tables II. and III.) gave in F_2 109 whites : 321 yellows, or 1w : 3y, exactly as in the corresponding generation following *single* matings of the same races.

Five matings of F_1 white with F_1 yellow (Table II.) gave 93 whites : 98 yellows, close equality of the two sorts, again *as in the single matings.*

Thus far we have no evidence of any departure in the double matings from Mendelian inheritance as strict as prevails in the single matings. If such departures occur they are to be found in the remainder of Kellogg's statistics, which are based on F_3 matings. No F_3 broods from single matings of the races under consideration are reported by Kellogg. Surely he has not overlooked the elementary fact that F_3 matings should on a Mendelian expectation produce a different result from the F_2 ones, yet on no other supposition can I account for the fact that Kellogg speaks of "irregularities" that occur with "non-Mendelian regularity." These "irregularities" of F_3 as compared with F_2 are not "non-Mendelian"; they are part of the Mendelian expectation as a moment's consideration will show. The F_1 individuals, whether yellows or whites, produced by a (single mating) cross of yellow with white are all heterozygous and so are expected to produce mixed broods, but of the F_2 individuals only *part* are heterozygous. The F_2 yellows from F_1 yellow pairs should be two thirds of them heterozygous like the F_1 yellows, but one third of them should be homozygous and so capable of producing all yellow broods. The same would be true also of the F_2 whites.

Kellogg reports seventeen matings *inter se* of F_2 yellows derived from F_1 ancestors, one or both of which were yellows. Six of these matings produced only yellow progeny indicating that the pair contained at least one homozygous yellow individual. One of the matings produced only white progeny, a surprising result if it is not a misprint. The remaining ten matings produced mixed broods, like those of the F_2 generation, aggregating 64 whites : 171 yellows, or 1w : 2.7y, a slight deficiency of yellows but no greater than the expected Mendelian deviations from the exact 1 : 3 ratio.

Let us now consider what is to be expected regarding F_2 whites mated *inter se.* If the egg of a Bagdad white female were fertilized by sperm of a Bagdad white male, we should expect F_1 and all subsequent generations from such fertilizations to contain only white individuals. Seven F_3 broods (Table II., summary) fall in this category as previously noted, being derived from seven different F_1 pairs coming from white F_1 pairs produced by a white mother doubly mated, but as regards these eggs evidently purely fertilized. These seven pairs produced only white offspring both in F_2 and in F_3.

In case the Bagdad white egg were fertilized by yellow sperm and gave yellow F_1 individuals which produced mixed broods, and white individuals from these broods were mated *inter se,* we should expect them to produce only white offspring, white being the recessive character in such cases and so presumably pure. Six of the F_2 white pairs (Table II.) fall in this category and produce only white F_3 offspring, except for one individual possibly a yellow "straggler," as suggested by Kellogg.

In case the F_2 white individuals were derived from a *crossed* (and so *dominant*) white F_1 individual mated with a yellow one likewise a dominant heterozygote, we should ex-

pect such F_2 whites to be in part heterozygous, but in larger part homozygous, and of these homozygotes some should be *dominant* whites. Now a homozygous dominant white individual, however mated, should produce only white offspring, and only occasionally would a *pair* of *heterozygous* dominant whites be secured, the condition necessary to allow yellow to recur in F_3. But we must remember that *homozygous* whites as well as heterozygous ones occur in F_1. Therefore matings of F_1 whites selected at random with yellows all known to be heterozygous should produce in a probable majority of cases white F_1 progeny which would be homozygous. Two of these mated together should, of course, breed true in F_3. Accordingly we expect pairs of F_2 whites in most cases to produce only white F_3 offspring. Kellogg records five F_2 matings of whites from white $\times$ yellow F_1 pairs (see Table II.). Of these, four produced only white F_3 individuals but one produced a mixed brood of 28 whites and 29 yellows.

Let us next consider what is to be expected from yellow $\times$ yellow F_2 pairs derived from white $\times$ yellow F_1 parents. The F_1 whites, as we have seen, are often homozygous. Therefore F_2 yellows descended from them are pretty sure to be heterozygous and should in general produce mixed broods. Kellogg records five such matings (see Table II.), four of which gave mixed broods aggregating 29 whites : 66 yellows, or approximately 1w : 2.3y. The fifth brood produced 9 offspring, all yellow. From so small a number it is impossible to decide whether one or both parents were homozygous in yellow, as seems probable. It is evident, however, that the great majority of the F_2 yellows of this origin are, as expected, heterozygous.

Finally mention should be made of a mating of F_2 yellows derived from white F_1 parents, which produced only yellow young in F_3. This seemingly contradictory result exactly accords with Mendelian expectation, for in this cross yellow was *recessive* in F_1, therefore upon reappearing in F_2 it should be *homozygous* and so breed true.

At every point, in this series of experiments, the Mendelian expectation is realized, not only in F_2, but also in F_3, if we base that expectation on the behavior of the same races in the single matings made by Kellogg. It is therefore idle to seek for explanations of "perturbed inheritance" due to double matings where no perturbation is discoverable.

In a second series of double matings made by Kellogg, the same white race (Bagdad) was employed together with "French yellow." In three matings (Table IV.) the French yellow female was used, and in the same number of cases (Table V.) the Bagdad white female was used. In each case the female was mated both with a male of her own race and with

TABLE IV. RESULTS OF MATING FRENCH YELLOW FEMALES DOUBLY, VIZ., WITH FRENCH YELLOW AND WITH BAGDAD WHITE MALES

F_1		F_2			F_3		
White	Yellow	Parents	White	Yellow	Parents	White	Yellow
57	74	Y × Y	8	22	W × W	all	0
					W × W	all	0
					Y × Y	0	all
					Y × Y	9	20
		Y × Y	5	14			
		Y × Y	2	23			
		W × Y	19	17	W × W	26	12
					W × W	19	6
		W × Y	17	21			
14	140	W × W	30	10	W × W	62	0
		W × W	20	10	W × W	"some"	"some"
					Y × Y	2	12
		Y × Y	2	18	Y × Y	1	4
		Y × Y	0	59	Y × Y	0	47
		W × Y	18	14	W × W	29	11
					Y × Y	3	1
		W × Y	10	10	W × W	93	25
					Y × Y	8	35
0	90	Y × Y	3	13	Y × Y	0	all
		Y × Y	8	17	Y × Y	6	10
Summary		*2*W × W	*50*	*20*	*1*W × W	*all*	*0*
					*1*W × W	*"some"*	*"some"*
					*1*Y × Y	*2*	*12*
		*6*Y × Y	*28*	*107*	*2*W × W	*all*	*0*
					*2*Y × Y	*0*	*all*
					*3*Y × Y	*16*	*34*
		*1*Y × Y	*0*	*59*	*1*Y × Y	*0*	*47*
		*4*W × Y	*64*	*62*	*4*W × W	*167*	*54*
					*2*Y × Y	*11*	*36*

one of the other race, as in the crosses with Istrian yellow.

In one case the French yellow mother produced only yellow offspring. This was evidently due to complete dominance of yellow in the cross, for white descendants were obtained both in F_2 and in F_3. In the two other broods produced by French yellow mothers, both white and yellow individuals occurred in F_1, so that dominance here alternated between yellow and white.

The reciprocal cross (Bagdad female × French yellow male, Table V.) gave a similar result. In one case, white was completely dominant; in the other two, mixed broods were obtained.

TABLE V. RESULTS OF MATING BAGDAD WHITE FEMALES DOUBLY, VIZ., WITH BAGDAD WHITE AND WITH FRENCH YELLOW MALES

F_1		F_2			F_3		
White	Yellow	Parents	White	Yellow	Parents	White	Yellow
all	0	W × W	111	44	W × W	all	0
					Y × Y	8	40
					Y × Y	9	29
		W × W	all	0	W × W	all	0
					W × W	15	2
		W × W	all	0	W × W	14	0
					W × W	17	4
25	13	W × W	1:	1	W × W	all	1(?)
					Y × Y	1	a few
		W × Y	1:	1	W × W	23	2
33	19	W × W	all	1(?)	W × W	all	0
		Y × Y	1:	1	W × W	9	1
		W × Y	22	0	W × W	a few	0
		W × Y	6	10	Y × Y	1:	1
Summary		*3*W × W	*all*	*1*(?)	*3*W × W	*all*	*0*
					*2*W × W	*32*	*6*
		*2*W × W	*111*	*44*	*2*W × W	*all*	*1*(?)
					*1*Y × Y	*1*(?)	a few
					*2*Y × Y	*17*	*69*
		*1*Y × Y	*1:*	*1*	*1*W × W	*9*	*1*
		*1*W × Y	*22*	*0*	*1*W × W	*a few*	*0*
		*2*W × Y	some	some	*1*W × W	*23*	*2*
					*1*Y × Y	*1:*	*1*

F_1 yellows from a French yellow mother were mated *inter se* in seven cases. One of the seven pairs produced only yellow F_2 offspring, 59 in number, and a pair of these gave, in F_3, 47 offspring all yellow, which result indicates that one or both of the F_1 yellows in this case were pure, being derived from a fertilization by sperm of the French yellow male. The remaining six pairs of F_1 yellows produced mixed F_2 broods aggregating 28 white : 107 yellow, or 1w : 3.8y, a small excess of yellows. Four matings of F_1 yellows with whites (Table IV., summary) produced mixed broods, aggregating 64 whites : 62 yellows, or 1w : 1y, as in similar matings (single or double) of Bagdad with Istrian yellow. Two matings of F_1 (dominant) whites from a French yellow mother (Table IV.) produced 50 whites : 20 yellows, where 3w : 1y are expected. In the reciprocal cross (Table V.) F_1 whites produced in two cases white offspring only and in a third case all white but one individual, a possible straggler, while two other pairs gave mixed F_2 broods. In case of the two F_1 pairs which produced only white F_2 offspring, it is evident that only one of the white parents can have been pure (derived from a white × white fertilization), for yellows were obtained in F_3 in three of the four matings made. Matings of F_1 whites with F_1 yellows were made in three cases, two of which produced mixed broods of approximately 1w : 1y; in the third mating the white was apparently pure (from a white × white fertilization), for the 22 F_2 offspring were all white, as were also the "few" F_3 offspring descended from them.

So far there is encountered nothing at variance with Mendelian expectation. But among the F_3 broods derived from this cross (Table V.) occur some minor irregularities. However, the numbers in these broods are in general very small, so that this part of the series can not be regarded as very satisfactory. The chief irregularity occurs among the F_3 progeny of a cross which had given whites only in F_1 and 111w : 44y in F_2, a consistent behavior of white as dominant. A pair of the F_2 whites produced an all white F_3 brood, also a consistent result, but two pairs of the F_2 yellows produced *mixed* F_3 broods, viz., 17w : 69y where we should have expected only yellow progeny in accordance with the *recessive* behavior of yellow in the two previous generations. (Compare the reciprocal cross,

Table IV., where this expectation is realized.) Dominance here has apparently shifted from the white to the yellow character. It would be a matter of great interest to know how the character would behave in later generations and whether the altered dominance may not be due to some independent factor interchangeable between white and yellow. We get no evidence of such a condition elsewhere in Kellogg's experiments, and the numerical proportions of the yellows and whites in these two broods are a slender basis on which to base such a hypothesis, but these two broods would form a good starting-point in looking for an explanation, if they were followed into later generations.

Kellogg's experiments seem to the writer to be of value not in respect to their double mating feature, which really has produced nothing at variance with the results of single matings, but in their demonstration, in common with Coutagne's experiments, of varying dominance, a matter as yet quite obscure and affording inviting material for further study. It is to be hoped that Professor Kellogg will not fail to put on record the further data mentioned in his paper.

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BUSSEY INSTITUTION,
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June 7, 1911

WHAT IS WHITE AND BLACK ALKALI?

THE popular distinction between "white" and "black" alkali salts in soils is of considerable practical importance, and anything that tends to confuse the farmers' ideas in this respect is regrettable; doubly so when official publications of experiment stations or the Department of Agriculture at Washington lend countenance to such confusion. The cultivation and reclamation of lands affected by alkali salts is comparatively simple when the alkali is "white," but always more risky and difficult when these are "black," and in the latter case are sometimes economically impracticable.

In a general way, black alkali is sodium carbonate, which after dissolving the humus of the soil, leaves black spots on the land where the solution has evaporated; while white alkali leaves only the white crust of the sulfate and chloride of sodium. Broadly speaking, the sulfate is quite four times less injurious to vegetation than the carbonate, while common salt stands in between in this respect.

Some years ago, it was stated in an official publication, that an observer had "discovered" that bicarbonate (hydrocarbonate) of sodium was frequently present in alkali salts; and as laboratory experiments had shown that the bicarbonate was not more injurious than the other two "white" salts, it should, therefore, be considered as part of the latter. And having been the first to investigate alkali lands in this country, I have been censured for overlooking such obvious facts, giving lands containing the bicarbonate an undeserved bad name.

Now any one familiar with the occurrence and behavior of the three sodium carbonates —the normal or monocarbonate, the sesquicarbonate (so-called) or trona, and the hydro- or bicarbonate, can readily understand the reason why I have considered the presence of either of these compounds in the soil equivalent to that of the others. The only one of them that occurs as a mineral in nature, and is stable under natural conditions, is the sesquicarbonate, occurring as trona wherever a solution of either of the other two evaporates spontaneously in the presence of atmospheric air. The monocarbonate absorbs carbonic dioxide from the air whenever exposed, so that when we want to obtain an accurately weighed quantity of the normal carbonate, we must first ignite it. On the other hand, the bicarbonate begins to lose carbon dioxid as soon as exposed to moist air, and upon evaporation its solution leaves a residue of sesquicarbonate, which acts practically as though it contained the normal carbonate, in dissolving humus, causing injury to vegetation, and puddling the soil.

It is thus obvious that, supposing a soil to contain a solution of bicarbonate only, the latter will, so soon as it is raised to the sur-

face by capillarity, at once begin to lose carbon dioxid, leaving a residue of sesquicarbonate; which will, without difficulty, dissolve the humus of the soil, and act in other respects precisely like the normal carbonate.

In view of the fact that the air of the soil always contains more carbonic dioxid than the air, any sodic carbonate it contains in solution will inevitably suffer transformation into bicarbonate to the extent to which carbonic acid happens to be found in the soil under the existing conditions of vegetable growth, temperature, moisture, and bacterial action in the oxidation of organic matter. It is a matter purely of seasonal accident; so that, if a soil sample happens to be taken at a time when carbon dioxid is abundantly forming, the chemist may find in it exclusively bicarbonate; while similar samples, taken a few weeks afterwards, may under the influence of aeration and drying, be found to contain, in the main, the sesquicarbonate.

I have therefore considered, and do now consider, the determination of *sodium bicarbonate* in the soils as quite immaterial for practical purposes, it being a variable and entirely uncertain factor; and inasmuch as ultimately the entire amount of sodic carbonates may serve for the formation of sesquicarbonate and the normal salt, I have thought best to calculate the entire amount of these carbonates found to the latter salt, without reference to the other two.

Of late, the official characterization of the hydrocarbonate salt as no more harmful than other white alkali, has led some chemists analyzing irrigation waters to recommend for that purpose, waters containing considerable amounts of sodium bicarbonate. In this case, the prospect of the accumulation of indefinite amounts of black alkali in the soil irrigated would be such a positive and inexcusable detriment, that it seems high time to put an end to the misleading statement which leads chemists, as well as farmers, to expose lands to serious injury.

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Berkeley, Cal.,
June, 1911

METALS ON METALS, WET

It is generally agreed that the coefficient of friction between metals (outside the physical laboratory) is a very elusive quantity. It is with the hope of suggesting some considerations not mentioned by Professor Hall[1] but of great practical importance that the following comments are offered.

The difference in coefficient of friction between driving wheel and rail, whether the latter is wet or dry, is relatively immaterial so far as the effect of using sand to prevent the slipping of the driving wheels is concerned. Sand is used on dry as well as wet rails, with a similar result in either case, namely, to increase the coefficient of friction between wheel and rail. The reason for this is obvious, since the sand particles become ground between the two surfaces, giving them, in effect, the roughness which greatly increases the coefficient of friction over that of the unsanded smooth surfaces.

It is also well known to railroad engineers that a cleanly washed wet rail, as after a heavy rain, is a "better" rail and is less likely to result in slipping of wheels than a perfectly dry rail. Of course a rail having slimy water or any foreign matter, such as coal dust, frost, etc., which can act as an ungent, results in lowering the coefficient of friction. It is because a wet rail is ordinarily greasy that sand is commonly used when the rail is wet, whereas, a dry rail is more apt to be gritty, due to the dust, etc. There is therefore less necessity for using sand.

Referring to Professor Hall's paragraph one, would not term "adhesion"[2] apply to the phenomena mentioned more accurately than term "friction"? A similar effect is noticed when a thin film of water separates two plates of glass.

Professor Hall's conclusion would seem to satisfactorily account for one phase of the problem, but, as stated above, the phenomenon

[1] Science, May 19, 1911, p. 775.

[2] See DuBois, "Mechanics of Engineering," Vol. 1, p. 220.

of friction, especially as it is met with in actual practise, is a most complex and elusive factor and in attempting to evaluate its effect or satisfactorily account for its mutations it is not safe to overlook any of the possible influences affecting the final results.

Since 1878 it has been known that Morin's laws regarding friction are absolutely unreliable except within a limited range of conditions. With heavy unit pressures between contact surfaces, such as exist over the small area of contact between driving wheel and rail or between a brake shoe and the wheel to which it is applied with the forces required to stop a modern passenger car under present-day service conditions within a reasonable distance, the coefficient of friction may fluctuate through wide ranges, due to the combined influence of pressure, relative speed of contact surfaces, temperature, continued rubbing and so on. For example, with cast-iron brake shoes on steel-tired wheels the effect of speed has been found to reduce the coefficient of friction from 33 per cent. when just moving, to less than 10 per cent. when at a speed of 60 miles per hour.

This subject is far too broad to warrant further discussion in such a communication as this, but any who may be interested in the experimental results obtained, and the conclusions drawn therefrom, are respectfully referred to papers presented before the British Institute of Mechanical Engineers, June and October, 1878, and April, 1879, by Captain Douglas Galton, describing the classic Westinghouse-Galton experiments on the effect of brakes on railway trains and a paper by Mr. R. A. Parke, in the *Railway Gazette* for June 14–21, 1901, entitled "Friction of Brake Shoes." Copies of the above will be gladly furnished gratis on application to the Westinghouse Air Brake Company, Wilmerding, Pa.

S. W. DUDLEY

QUOTATIONS

ADMISSION TO HARVARD COLLEGE

THE new alternative plan of admission to Harvard College, announced to the schools only a few months ago, was given its initial test at the entrance examinations of last week. The results, so far as one may judge at this early date, were in every way distinctly promising. Over one hundred candidates for admission took advantage of the new provisions, which seems to warrant a belief that the schools already realize the possibilities of the scheme as a method of getting their best pupils into Harvard, and that if this year's results prove satisfactory the number of applications for entrance under the alternative arrangements will show a large increase next year.

Even more significant, moreover, is the fact that of these hundred candidates more than half are from schools outside New England. It was precisely to this constituency—the public high schools outside New England—that the new plan was meant to be of service. It was devised primarily as a means of admitting to Harvard bright boys from distant schools who had pursued good four-year preparatory courses, but who had not been hammered into the particular grooves marked out by the old entrance requirements. The schools of New England, whether public or private, find no very great difficulty in meeting these requirements, and many of them, doubtless, will continue to send their boys along the old route. But the public high schools of the middle states, the west and the south have hitherto found the task of fitting boys for Harvard to be much more difficult, and it was to them that the framers of the new admission plan hoped to afford relief. These schools have responded in the most encouraging fashion at the very outset.

It will not, of course, be possible to draw any definite conclusions concerning the quality of the students admitted under the new requirements until they have passed a year or two in the college, side by side with students who have come to us under the old provisions; but the testimony of those who have been reading the examination books indicates that there is every ground for optimism in this

regard. The schools seem to have met the new arrangements with cordiality and good spirit.—*Harvard Alumni Bulletin.*

SCIENTIFIC BOOKS

Reports to the Local Government Board on Public Health and Medical Subjects (New Series, No. 53). Further Reports (No. 4) on Flies as Carriers of Infection. Pp. 48. Bacon Street, E., London, Darling and Son, Limited. 1911.

This latest number of this very valuable series of reports on flies as carriers of infection includes four articles of cosmopolitan interest: Dr. Copeman, Mr. Howlett and Mr. Merriman report upon an experimental investigation in the range of flight of flies; Mr. Austen presents a memorandum on the result of examinations of flies from Postwick Village and refuse deposit; Dr. Nicoll discusses the part played by flies in the dispersal of the eggs of parasitic worms, and Dr. Graham-Smith gives further observations on the ways in which artificially infected flies carry and distribute pathogenic and other bacteria.

The investigation on the range of flight of flies, by Dr. Copeman, Mr. Howlett and Mr. Merriman, is of great importance and is one which is very difficult to carry to a practical conclusion. Its value in deciding, in practical anti-fly work, the distance from a given point to which it is necessary to carry the abolition of possible breeding places is fundamental. It necessitates the use of a method of marking flies which will not interfere with their normal habits, and can at the best indicate only certainties of observation. It is shown in this report that marked flies in the series of observations were recovered at distances varying from 400 yards to 1,408 yards from the point where they were marked, thus indicating a flight of more than three quarters of a mile. The writer of this notice, in his recently published book "The House Fly —Disease Carrier," brought together all of the previously recorded observations on this point, but was unable to find any substantial records of distances equal to this. While it is true that the probabilities strongly favor a more extended flight, these observations nevertheless record the longest scientifically observed flight and indicate that for at least three quarters of a mile around a given point breeding places must be treated or abolished if the nuisance and danger of the house fly are to be avoided. It should be stated that, in the text on page 8, a distance of 1,700 yards is indicated, but this does not appear in the table. Accepting 1,700 yards, the observed limit of distribution reaches nearly a mile. The authors note that the direction of the prevailing wind is an important factor, and that the time of the distribution observations was forty-eight hours.

Dr. Nicoll, in his consideration of the part played by flies in the dispersal of the eggs of parasitic worms, shows that flies may convey such eggs from excrement to food in two ways, namely, on the external surface of the body and in the intestine. The latter mode occurs only where the eggs are of small size (under 0.05 mm. in diameter). Larger eggs may be carried on the external surface, but these are usually removed by the fly within a short time. Others which are taken into the intestine may remain there for two days or longer, and may remain alive and subsequently cause infection. The eggs of the following parasitic worms have been shown experimentally to be capable of being carried by *Musca domestica: Tænia solium, Tænia serrata, Tænia marginata, Hymenolepis nana, Dipylidium caninum, Dibothriocephalus latus* (?), *Oxyuris vermicularis, Trichuris* (*Trichocephalus*) *trichiurus,* both internally and externally; *Necator americanus, Ankylostoma caninum, Sclerostomum equinum, Ascaris megalocephala, Toxascaris limbata* (=*Ascaris canis* e. p.), *Hymenolepis diminuta* externally only. No Trematode parasites have as yet been experimented with in this investigation.

Dr. Graham-Smith concludes that both house flies and blow-flies are capable of infecting fluids, such as milk and syrup, on which they feed and into which they fall. In the case of the house fly, infected with certain micro-organisms (*B. prodigiosus* and *B. anthracis*), gross infection may be produced in

milk for at least three days, and a smaller degree of infection for ten days or even longer. At the same time he shows that blow-flies produce gross infection for six to nine days with non-spore-bearing micro-organisms and some degree of infection for three or four weeks. The investigator thinks that it is probable, at any rate in the later stages, that infection is mainly due either to direct infection with the crop contents vomited through the proboscis, or to direct infection by means of the limbs which have been reinfected with vomited material.

These experiments were so conducted as to afford no information as to the extent to which house flies bred from larvæ fed on naturally infected excreta and similar materials are apt themselves to be infected.

L. O. HOWARD

Lectures on Fundamental Concepts of Algebra and Geometry. By J. W. YOUNG. Prepared for publication with the cooperation of W. W. DENTON, with a note on the growth of algebraic symbolism by W. G. MITCHELL. Pp. vii + 247. New York, The Macmillan Company. 1911.

While the teacher of secondary mathematics finds a large amount of English literature on the teaching of his subject he looks in vain for much that is well adapted to give him a deep insight into the fundamental theory of the subjects with which he has to deal. The English language contains no encyclopedia on elementary mathematics like Weber and Wellstein's "Enzyklopädie der Elementarmathematik," or like the new Italian encyclopedia which is being prepared. It has no histories like Cantor's or even like Tropfke's. It has no periodical like *L'Enseignement Mathématique,* and no large mathematical encyclopedias like the great works which are now being published in German and in French.

Although the small size of the book under review precludes any hopes that we might have here a work to which the teacher of secondary mathematics may turn for an answer to most of his questions, yet he will find here an unusually clear exposition of a large number of things relating to the logical foundation of algebra and geometry. The brevity of the exposition will doubtless be welcomed by many who are looking for a first general survey of some basic matters, and it is to be hoped that they may become sufficiently interested to pursue the thoughts further, as they are encouraged to do by a fair number of references.

The book is modern in spirit, and, to a large extent also, in subject matter. Considerable attention is given to historical settings but the logical element receives the greatest emphasis. It opens up view points which are of great interest even if they may not always be acceptable to the reader. From the nature of the case many of the questions treated are such as to give rise to different views, but their fundamental importance justifies inquiries even if these do not always receive a complete answer. One of the most important lessons for the young mathematician to learn is a keen realization of the narrow limits of the explored parts of mathematics as compared with those regions which invite our inquiry and baffle our efforts.

The contents of the volume can be readily inferred, in the main, from its title. After a brief consideration of Euclid's elements and non-euclidean geometry, the author considers the logical significance of definitions, axioms and postulates, the consistency, independence and categoricalness of a set of assumptions. This is followed by a consideration of the fundamental notions of class, correspondence and group, and the development of the concepts of real and complex numbers. It is pointed out that from the abstract point of view algebra and geometry are identical in the sense that each includes the other, and that this explains the interrelations between these subjects.

On page 194 the author repeats a historical error which is very wide spread in mathematical literature, as regards the early use of the term function for integral power of a variable. This error seems to have been started by d'Alembert and it has been re-

peated by a large number of prominent mathematicians.[1] That the graph on page 214 is the graphic representation of the function in question is open to serious doubts, which should not have been passed over in a work on logical foundations. The statement on page 101 that "Diophantus of Alexandria. who lived 300 A.D., seems to have been the first actually to have made use of rational numbers" is apt to mislead the reader even if a footnote helps to ascertain the author's meaning. Taken by itself this statement seems absurd.

These are, however, matters of secondary importance and the book under review seems to be remarkably free from errors if we consider its wide scope. In particular, the proof seems to have been read with unusual care and one can only wish that the book will be very widely read, especially by those who are preparing to teach secondary mathematics. Its style is attractive and many of the questions which it treats are so far reaching that one may reasonably expect that it will find a considerable number of readers outside of the circle of professional mathematicians.

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[1] Cf. "Encyclopédie des Sciences Mathematiques," Tome 2, Vol. 1, p. 3; Cantor's "Geschichte," Vol. 3, 1901, pp. 215, 456–7.

SPECIAL ARTICLES

COLOR DISPERSION IN THE ASTIGMATIC EYE

When an astigmatic eye views a bright point of light in which only the rays near the ends of the visible spectrum are present, the image of the source is blurred by fringes or wings of red and blue. If the eye has a well-defined axis of astigmatism but is otherwise fairly emmetropic, the appearance of such a source is so curious as to compel attention. The purplish image is then crossed by a pronounced red band parallel to that meridian of the eye in which the curvature is least, and by a blue band at right angles to it. In the case of astigmatism with the rule, the red band is approximately horizontal. The experiment is easily tried in a darkened room by allowing the light from a flame or electric lamp to pass through a hole a few millimeters in diameter in a screen, or better by placing the lamp in a box having a small hole in one side. One or two thicknesses of common "pot blue" glass are placed over the opening, which is then viewed from a distance of two meters or more. The blue glass, as is well known, is fairly transparent to red light. Distant blue lights seen at night, such as the "dwarf signals" in railroad yards, show the effect well.[1] Indeed, the appearance can be seen by viewing any bright light through a blue glass held in front of the eye. A person free from astigmatism can see the effect by holding a cylindrical lens in front of the eye.

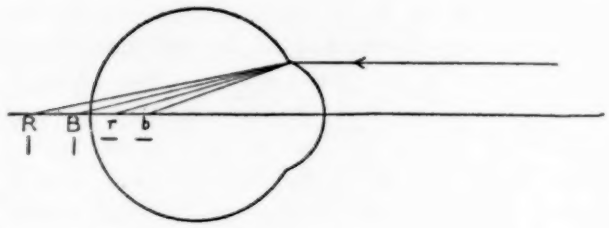
The explanation is simple, and has very likely occurred to many who have noticed the effect. However, the writer has been unable to find any reference to it, either in the classical memoirs of Helmholtz and his predecessors, or in such later writings as he has access to. Astigmatic vision seems to have been considered only on the tacit assumption that dispersion could be neglected—an assumption that is sufficient with ordinary white light, in which the yellow and green rays predominate in determining our visual sensations. It is only when these intermediate rays are excluded that the effects of dispersion become noticeable.[2]

Taking the type of astigmatism most commonly found, let us assume that the radius of curvature of the cornea is less for the vertical than for the horizontal meridian. If the eye observes a distant point-source giving only

[1] Among those whom the writer asked whether they had noticed the crossed red and blue bands was a certain railroad employé, who not only observed the appearance to a marked degree, but also volunteered the explanation that the dwarf signal "had a dirty glass." Remarks of this sort show how unconscious we are of our own defects of vision.

[2] For example, Helmholtz describes some interesting experiments on the effects of chromatic dispersion in the eye; these are also recounted by Lummer in Müller-Pouillet's "Lehrbuch der Physik." In all these cases the eye is assumed to be free from astigmatic defects.

red and blue rays, then the foci for these rays with respect to the curvature of the vertical meridian will fall, say, at r and b, while the foci with respect to the curvature of the horizontal meridian will fall at R and B respectively. The relative distances are exaggerated for the sake of clearness. Helmholtz gives the distance between the focal planes for red and violet (RB or rb in the diagram) as about 0.6 mm. Whether r falls to the right or left of B depends on the degree of astigma-



tism. In an otherwise emmetropic eye focused on infinity the retina will be somewhere between the points B and r. If the accommodation is such that the point R falls on the retina, the eye perceives instead of a point a vertical red band. The direction of the bands is indicated by short lines under the letters in the diagram. A horizontal blue band is perceived if the point b falls on the retina, in each case the band being surrounded by an indistinct halo due to the other images. If B and r fall close enough to the retina, R and b will be out of focus and practically indistinguishable, so that only a horizonal red band crossing a vertical band of blue will be seen. While the writer normally sees these bands crossing, he is able, by changing the accommodation of the eye, to observe the vertical red band (surrounded by a bluish halo) or the horizontal blue band. To see the two bands crossing, the degree of astigmatism must, of course, fall between certain limits, but these limits turn out to be surprisingly wide, partly because the appearance of crossed bands is heightened by the effects of contrast, partly because the bands become longer with increasing astigmatism. As would be expected, the red band *looks* nearer than the blue.

As for the quantitative relations, it is easy to show that there is a degree of astigmatism, well within the limits commonly found, for which the crossed red and blue bands are in focus simultaneously. For Helmholtz, as stated above, shows that the distance RB between the focal lengths for red and blue due to dispersion is about 0.6 mm. On the other hand, in an astigmatic eye the difference between the focal lengths due to the two curvatures at right angles (Rr or Bb) may be anything from zero to 2 mm. or more. Thus an eye need be only slightly astigmatic (correction about 1.5 diopters) in order to bring the points B and r into coincidence.

If the eye has an astigmatism so complex that several astigmatic axes in different planes have to be dealt with, the red and blue bands are correspondingly complex. Indeed, this method might perhaps prove useful in the examination of astigmatic eyes. By placing cylindrical lenses of varying focal lengths before the eye, it is possible to tell by the disappearance of the bands when the optimum correction has been attained. It may be remarked in passing that the phenomenon of color dispersion furnishes an interesting demonstration of the manner in which ametropia is corrected. For, as is well known, farsighted and near-sighted eyes perceive purple sources as surrounded by a red or a blue halo respectively, and this halo can be increased, or reduced to a well-marked minimum, by the use of suitable spherical lenses.

Even a small source of *white* light looks a little ruddier on two opposite sides if the eye is astigmatic.

Very peculiar effects are produced in an astigmatic eye by repeating the experiments described above with a purple or "blue" light, using in place of a round hole a row or group of pinholes, or a slit, or a maltese cross set at varying angles.

To show the crossed red and blue bands objectively, an astigmatic lens of high dispersion was made in the following manner: the surface of a large incandescent bulb was tested at different points, until a region was found where the ratio of the curvatures in planes parallel and at right angles to the axis of the bulb was of the desired value (a 60-

watt tungsten lamp was the largest available giving the required ratio). This ratio was computed from a consideration of the wave-lengths transmitted by the blue glass used, namely, about 710 and 420 $\mu\mu$, and of the indices of refraction of carbon disulphide for these wave-lengths. This part of the bulb was cut out, forming a sort of shallow bowl into which a quantity of carbon disulphide was poured. I thus had an astigmatic plano-convex lens which gave as an image a minute red-and-blue cross when purple light was passed vertically through it. Later the fragment of the bulb was cemented with shellac on to a flat piece of glass, forming a cell into which the carbon disulphide could be introduced. A diagram was used to screen off all but a small portion of the lens.

In a rudimentary way the appearance can be projected on to a screen by passing light obliquely through a common plano-convex lens.[3]

W. G. Cady

Wesleyan University

THE IOWA ACADEMY OF SCIENCE

The sessions of the academy were held in Carnegie Science Hall, Coe College, Cedar Rapids, April 28 and 29.

The public address by Dr. Edward L. Nichols, of Cornell University, on "The Ends of the Spectrum—the Infra-red and the Ultra-violet," was given on Friday at 8:00 P.M.

Sessions of the academy for the reading of papers were open to the public.

Nitrogen in Rain and Snow: Nicholas Knight.

Seventeen samples of rain and snow were collected on the college campus at Mt. Vernon, Iowa, during nine months of the year 1909–1910. The nitrogen in the free and albuminoid ammonia and in the nitrates and nitrites was determined. Comparisons were made of the relative amounts of nitrogen precipitated with the rain and snow. According to the experiments, each acre would receive in the nine months between thirteen and fourteen pounds of nitrogen from the rains and snows.

Perchloric Acid in Electro-chemical Analysis: W. S. Hendrixson.

Asteroid, 1909, JA: Seth Nicholson and Alma Stots.

Vaccination against Typhoid Fever: Henry Albert.

The writer briefly reviewed the experimental work on immunization with cultures of typhoid bacilli, then gave the technique and preparation of vaccine as generally employed at present for the preventive vaccination against typhoid fever. The reaction was divided into a local one which disappears in the course of a few days and a general one which he divided into leucocytic, phagocytic, agglutinitic and bacteriolytic. There is an increase in the number of leucocytes, the power of phagocytosis, and of the agglutinins and bacteriolysins in the blood serum. The presence of immune bodies may be demonstrated as long as one year after vaccination and is of both a higher degree and of longer duration than usually occurs following an attack of typhoid fever. Reasoning from analogy from the protection afforded by one attack of the disease, he believes that the immunity conferred by vaccination exerts more or less protective influence throughout the life of an individual. He would extend anti-typhoid vaccination to all liable to exposure to infection with typhoid fever.

Flowers of Story County: J. M. Lindley.

The Succession of Floras on the Sand Dunes of Iowa: B. Shimek.

A discussion of the changes of the earliest flora of these dunes, consisting largely of leguminose plants, to the typical prairie flora of the older areas.

The Nebraskan Drift: B. Shimek.

A discussion of its distribution and correlation, including the results of recent investigations. The conclusion is reached that this drift can not be correlated with the Jerseyan and Albertan, and that the name "Kansan" should not be transferred to it.

Notes on Fungus Diseases: L. H. Pammel.

Gives a record of a very destructive *Exoascus* upon the hard maple in the Rocky Mountains, also an account of the destructive *Exoascus* on the oak, the destructive *Fomes iginarius* on the quaking aspen in some parts of the Wasatch Mountains in Utah, as well as the destructive work of *Pleurotus* upon the box elder and other deciduous trees in Iowa.

An Abnormal Carpel in Stenospermatium: J. E. Gow.

[3] I am indebted to Professor Raymond Dodge for this suggestion.

Notes in Regard to Efficiencies of Luminous Flames: G. W. STEWART.

An investigation of the efficiency of luminous flames would be of interest. Results obtained incidentally were studied, showing that a cylindrical acetylene flame is not so efficient as a flat acetylene flame when judged by the proportion of its radiant energy that is visible. The amount of visible radiant energy that a given quantity is able to furnish should also be considered. Experiments with a flat kerosene flame show a height of flame at which the candle-power-hours-per-gram is a maximum. The problem of obtaining the most efficient flame, in the broadest sense, is complex. It is advisable to get the temperature of the incandescent particles as high as possible, and also to get as many of them per gram of the illuminant as possible. Both of these factors depend upon the shape of the flame.

On the Rate of Recovery of the Elastic Properties of a Certain Wire: L. P. SIEG.

The Measurement of Musical Capacity: C. E. SEASHORE.

The speaker outlined a series of measurements and statistics for a quantitative determination of musical capacity. The principal measurements are on pitch discrimination, perception of consonance and dissonance, tonal memory, tonal imagery, discrimination for intensity of sound, the appreciation of rhythm, rhythmic action and voluntary control of pitch of voice. These exact measurements were supplemented by returns to an elaborate questionnaire on musical education and appreciation and a personal interview after the statistics had been collected.

Illuminating Engineering—A New Profession: ARTHUR H. FORD.

Some Remarks on the Solubility of Certain Salts in Water: LEROY D. WELD.

Notes on the Pollination and Variation of Red Clover (Trifolium pratense): L. H. PAMMEL and CHARLOTTE M. KING.

Giving notes on the more important insects that pollinate the red clover in the state of Iowa and their relation to fertility; compares the amount of seeds produced per head and the number of flowers, showing an extreme variation.

The Ecology of a Prairie Formation with Adjacent Swamp and Woodland in Story County, Iowa: ADA HAYDEN.

Gives a physiographic account of the region with a physical analysis of the soil and the temperature records for an entire growing season and a list of plants found on each formation and the repopulation of tillable soil which is reverting to prairie.

Some Notes on Iowa Fungi: T. H. MACBRIDE.

The Flowers of Myriophyllum spicatum: N. D. KNUPP.

Glaciated Rock Surfaces near Linn and at Quarry: W. H. NORTON.

Some Features of the Bering River Coal Field, Alaska: GEORGE F. KAY.

Problems on the Border Lines between Geology and the other Sciences: GEORGE F. KAY.

In this paper attention is called to the need of cooperative work among investigators in the different fields of science. Reference is made to several bulletins and papers which have already been published by the chemists of the United States Geological Survey, by the physicists of the geophysical laboratory, and by other scientists, throwing light on many problems in geology which heretofore were obscure. The necessity for further work upon border problems, already under investigation, and upon many other problems which need solution, is emphasized.

Graphics of Ore Origin: CHARLES R. KEYES.

In calling attention to some of the newest aspects of ore genesis charts were prepared showing (1) the old conceptions of the origin of ore deposits, (2) the later ideas of secondary sulphide enrichment and (3) the latest views concerning the genesis of ore deposits generally. The last mentioned is presented as a rational scheme for a genetic classification of ore deposits.

Depositional Phases of Eolation under the Stimulus of Aridity: CHARLES R. KEYES.

It is now a question whether wind-scour under the stimulus of a typically arid climate is not actually the most potent and persistent of all erosive agencies. Under favorable conditions its general efficiency must greatly exceed that of stream-action in normally moist lands. At any rate, erosionally, its world's work is probably surpassed neither by that of hydrasion nor by that of glaciation.

Volcanic Phenomena of Coon Butte Region, Arizona: CHARLES R. KEYES.

Contrary to the recently expressed views regarding the origin of this remarkable crater, the most critical evidences seem to indicate that this feature of the local landscape is only one of the many manifestations of the explosive type of vulcanism so prevalent throughout the region.

Some Characteristics of Light-negative Selenium: Miss Lilah B. Crum.

The Use of a Ballistic Galvanometer and a Pendulum for Measuring rapidly Fluctuating Resistances: Wm. H. Clark.

Many methods for measuring constant resistances are employed. The method here described is one that we have used in the physical laboratory at the State University of Iowa to measure a fluctuating resistance. The apparatus consists of a pendulum, a Wheatstone bridge mesh including a battery of small E.M.F., and a galvanometer. The unknown resistance in the fourth arm of the bridge in this particular case happened to be a selenium cell. The pendulum was about thirty inches in length and swung through an arc of twenty-eight inches. The arc over which it swung was graduated with respect to time, the smallest division being .00125 sec. The period of vibration was .6 sec. Four keys adjusted to open and close two electrical circuits were placed on the arc over which the pendulum swung. The operation of the first two keys illuminated the selenium cell, the second two keys operated the galvanometer circuit. The length of time that either circuit was closed was determined by the distance between the two keys which opened and closed that circuit. Keys k_1 and k_2 which operated the lighting circuit were placed a given distance apart corresponding to the desired length of exposure of the cell to light. Then keys k_3 and k_4 were placed apart a constant distance equal to .05 sec. If the change of resistance is called Δx and the length of exposure to light is called Δt, then $\Delta x = cd/\Delta t$ where d is the deflection and c is the galvanometer constant. This equation is used for small resistances. When Δx becomes comparable to x another device is employed. Since Δx is a function of the deflection we replace the unknown fluctuating resistance by a known variable resistance and, keeping the ratio arms of the bridge the same, vary the resistance to secure deflections covering the same range of scale. A curve between change of resistance and deflection is plotted. Then for any deflection caused by the fluctuation of the unknown resistance we can at once read from this curve the corresponding change of resistance. The method is probably as accurate and as easy to manipulate as any method that has been devised for measuring rapidly fluctuating resistances.

The Nature of Light-action in Selenium: F. C. Brown.

The Doppler Effect in Electrodeless Discharge: Frank F. Almy.

Some Laboratory Apparatus in Elementary Physical Measurements: Frank F. Almy.

The Action of Epinephrin upon the Muscle Tissue of the Vein: John McClintock.

A Method for Studying Embryos as Related to Medical Work: H. J. Prentiss.

The Peripheral Distribution of Cranial Nerves in Necturus maculatus: H. W. Norris and Margaret Buckley.

The Zoological Rank of Necturus as Indicated by the Origin and Distribution of its Cranial Nerves: H. W. Norris.

Notes on Methods for the Study of Amphibian Eggs and Larvæ: Albert Kuntz.

The Development of Lymph Channels in Turtles by the Fusion of Mesenchymal Spaces: Frank A. Stromsten.

1. The theory that the lymphatic system is budded off from the venous system is a direct product of a special method of investigation, *i. e.*, the injection method.

2. The injection method alone is entirely unreliable, because: (*a*) Only that portion of the lymphatic system which is in direct connection with the point of injection (lymph sacs) is shown, the unconnected spaces are not indicated. (*b*) Extravasations and venous injections vitiate the results.

3. Serial sections, both injected and uninjected, of turtle embryos of different ages show the successive stages of the development of lymphatics from the spongy mesenchyme surrounding the aorta and larger arteries, through the formation of independent spaces which constantly enlarge and finally fuse to form continuous channels.

4. The endothelium of the lymphatics arises entirely independent of the venous endothelium from the original mesenchymal cells.

Some Notes on Iowa Reptiles: M. P. Somes.

Building a Museum: T. Van Hyning.

An outline plan of building an Iowa state museum; showing the approximate amount of museum material in the state required for a museum, together with showing the number of cases required, case space, floor space, etc., for a completed museum representative of the state. A cooperative plan of school museums, whereby the schools of the state may cooperate with the state museum in supplying a museum for all of the schools is proposed.

Notes on the Black-Crowned Heron: B. H. Bailey.

The College Museum: B. H. Bailey.

(Abstracts furnished by the authors.)

Eighty-eight new names were added to the roll of membership. The meeting of 1912 will be held at the State Historical Building in Des Moines, and will be a meeting celebrating the twenty-fifth anniversary of the organization of the academy.

Officers elected for the ensuing year are:

President—Louis Begeman, Cedar Falls.

First Vice-president—A. A. Bennett, Ames.

Second Vice-president—C. N. Kinney, Des Moines.

Secretary—L. S. Ross, Des Moines.

Treasurer—G. F. Kay, Iowa City.

Members of the Executive Committee—H. S. Conard, Crinnell; B. H. Bailey, Cedar Rapids; H. M. Kelley, Mt. Vernon.

L. S. ROSS,
Secretary

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 696th meeting was held on May 20, 1911, Vice-president Fischer in the chair. Three papers were read.

Experiments with Different Types of Voltameters: Mr. G. W. VINAL, of the Bureau of Standards.

According to Faraday's law for electrolytes the deposits of silver in different types of voltameters should be equal when the same number of coulombs of electricity has passed through each, provided, however, that there are no secondary reactions taking place. Differences in weight and appearance have been observed, particularly between the porous cup and filter paper forms. We have endeavored to find an explanation of these effects and to push the accuracy of our measurements beyond the limits hitherto attained. A constant temperature balance room has obviated the difficulties usually encountered in weighing the platinum bowls. The current has been measured by balancing the po'ential drop across a standard resistance against the voltage of a Weston cell and also by the potentiometer method. The purity of the electrolyte is of great importance and the tests will be discussed elsewhere.

The Kohlrausch, or no septum form as we have used it, consists of a glass dish under the anode and a ring of glass in the surface of the liquid to prevent the slime formed during electrolysis from reaching the cathode.

The siphon voltameter is unsatisfactory even when short siphons of large diameters are used, owing to the heating and large volume of electrolyte which may yield erroneous results if the electrolyte is not quite pure.

The filter paper form devised by Lord Rayleigh employs a sheet of filter paper to separate the anode and cathode. We have found the deposits in it abnormally heavy and striated in appearance, which effects are due to the filter paper not being chemically inert. Striated deposits are always heavy. We have studied the cause for striations and find two conditions to be necessary and sufficient for their production, viz., (1) the presence of reducing impurities in the electrolyte, (2) the motion of the liquid over the face of the cathode. When both of these conditions are fulfilled we may suppose any given initial distribution of points of silver which will grow in the direction of the liquid currents (usually vertical) since the crystalline structure is destroyed by colloidal deposits. In this way a crystal grows into the one above it and eventually a striation is formed. The initial spacing of the crystals and consequently the spacing of the striations is dependent on the current density.

T. W. Richards has advocated the use of a porous cup instead of filter paper to more perfectly separate the anode and cathode liquids. He gave as a reason for this substitution that a heavy complex ion could pass through the filter paper and increase the weight of deposit, but we have found that by using two or three thicknesses of filter paper the effect instead of being diminished is materially increased. The evidence of our work does not support the complex ion theory.

We have used two sizes of porous cup voltameters and find that with electrolytes, a trifle impure, that the larger will give the heavier deposit. This phenomenon we have called the "volume effect." It is a severe test of the purity of the electrolyte. With pure electrolytes the deposits in this form are always crystalline and free from striations. The efficiency of the porous cup as a separator of the anode and cathode liquids is shown by the fact that an impure solution may be placed inside the porous cup without affecting the deposit outside or if the deposit from a contaminated solution be compared with the deposit from the same solution after filtering through a porous cup it will be noted that the striations have disappeared from the deposit.

The small porous cup voltameter possesses many advantages over the other forms. We find from a long series of determinations two identical voltameters of this type will agree to within one part in 100,000.

The London Conference of 1908 has declared that the electro-chemical equivalent of silver is 1.11800 mg. per coulomb, and, therefore, using this value and the international ohm and the second we find the voltage of the Weston normal cell at 20° C. to be

1.01827 volts, ± .00003.

The Chemistry of the Silver Voltameter: Dr. A. S. McDaniel, of the Bureau of Standards.

The first problem in the chemical investigation of the voltameter was an investigation of the filter paper septum. This led to the detection of the classes of impurities in the voltameter. The plan of investigation of the filter paper form of voltameter was outlined. In this connection Smith's work at the National Physical Laboratory was mentioned. He added substances to the electrolyte to produce the observed striations in the deposits, and hence concluded that the striations were due to the impurities of the electrolyte. The speaker had also produced the striations experimentally. Tests were also made by the speaker to test the effect of the filter paper upon the striations. The striations produced by certain substances added to the electrolyte were described and illustrated by lantern slides.

Experiments were tried of extracting the impurities from the filter papers by soaking them in water and then drying them in the voltameter, but it was found that the striations were still produced. It was concluded from this that oxicellulose (oxidized filter paper) caused the active principle of the striations. The degree of acidity or alkalinity has quite an effect in determining the direction of travel of the colloidal deposit or particles.

Tests were also made to account for the increase in weight of the colloidal deposit on the cathode. The effect of silk and porous pot septa in voltameters was also investigated. The treatment of the pot before use to make it sufficiently resistant, and the action of the pot on the silver nitrate, were briefly stated.

The preparation of liquids for use in the voltameter were described, and mention was made of the determination of the electro-chemical equivalent of silver nitrate.

The Silver Voltameter as an International Electrical Standard: Dr. E. B. Rosa, of the Bureau of Standards.

The silver voltameter has been used as the official standard for the measurement of electric current since the International Electrical Congress which met in Chicago in 1893. The definitions and specifications for the fundamental electrical units recommended by the Chicago congress were adopted by the United States and several other countries in 1894. Germany, however, did not act in the matter until 1898 and then adopted somewhat different definitions and a different numerical value for the Clark standard cell which resulted in a different value of the volt. Austria and some other countries followed the example of Germany, so that for the last twelve years the ampere and volt have been slightly different in one group of countries from its value in the other countries. The International Congress at London in 1908 came to an agreement on the definitions such that there might be international uniformity, but could not fix upon the value of the standard cell for want of complete specifications of the silver voltameter and also for want of agreement among different experimenters with the silver voltameter. It was for the purpose of clearing up some of the mysteries in connection with this instrument, which has been the subject of more than forty scientific papers by investigators in several different countries during the last thirty years, that the work was taken up at the Bureau of Standards three years ago and has been carried on continuously ever since. One year ago an international committee representing four of the national standards laboratories met in Washington and carried out a series of investigations at the Bureau of Standards chiefly upon the silver voltameter. As a result of these investigations a new value for the Weston cell was agreed upon after recommendation to the International Committee on Electrical Units and Standards and that value has since been adopted, so that we now have in America the same value for the volt and ampere as is used in the principal countries of the world; this value will, undoubtedly, soon become universal. There still remain some outstanding questions in connection with the silver voltameter which must be solved before complete specifications can be agreed upon, but the investigations at the Bureau of Standards and elsewhere during the last two or three years have cleared up many of the questions which were outstanding at the time of the London conference in 1908.

(The first and last of the above abstracts are by the authors of the papers.)

R. L. Faris,
Secretary